Dyadic Cognitive Problem Solving of Old Couples:

Introducing New Paradigms

Thesis

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by

Ursula Maria Colberg

of Germany and Winkel ZH

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Prof. Dr. Mike Martin and Prof. Dr. Rainer Hornung

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Acknowledgement

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It is not how old you are but how you are old

Jules Renard

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1 General introduction

During the next decades the number of couples aged 65 and older will rise due to higher life expectancy of both genders (Bundesamt für Statistik, Schweiz 2005, Mikrozensus 2006, Deutschland; Statistical Abstract of the United States, 2000). These couples will have to master tasks, responsibilities, and problems of their daily lives jointly, often up to very old age. Problems to solve may arise through personal health changes in one or both partners. Social changes, such as children and grandchildren moving away or neighbors and friends not being available any further due to death or nursing home residency, may also require dyadic problem solving skills to adapt to the new living situation. Technological changes in household machines, ticket machines for public transportation and the increase of computerized tasks in everyday life need to be mastered as well. Financial changes for the elderly may also present problems to solve for an aging couple. To master these problems in their daily life, older couples need not only cooperation and respect for each other, but also the willingness to complement each other when necessary. Overall, dyadic cognitive problem solving skills will increasingly be required to solve everyday problems in aging couples.

Problem solving is considered the most complex of all intellectual functions and has been defined as higher-order cognitive process that requires the modulation and control of more routine or fundamental skills (Goldstein & Levin, 1987) such as planning, learning, memory, retrieval and decision-making (Canestrari, 1963; Cerella, Poon, & Fozard, 1982; Geraerts, Marcoen, &Verhaegen, 2000; Salthouse, 1993, 1994a). Since in everyday life it is obvious that using these fundamental skills, i.e., one or all of them, to solve problems, they have typically been investigated separately as predictors of young and old individuals' problem solving performance. The results gave answers to the question how well young and old individuals use their fundamental skills when solving problems. But what is known about when these fundamental skills are used in dyadic cognitive problem solving?

Dyadic planning has been investigated through errand planning by Berg, Johnson, Meegan, & Strough, 2003, and Margrett & Marsiske, 2002 (for a review see Martin & Wight, 2008). Dyadic memory was examined through story recall, vacation description, and item recall from a shopping list (Dixon & Gould, 1998; Gould, Lee, & Dixon, 1991; Gould & Dixon 1993; Ross, Spencer, Linardatos, Lam, Perunovic, 2004). Staudinger & Baltes (1996) reviewed dyadic decision making using a wisdom paradigm, while Margrett & Marsiske (2002), and Berg, Johnson, Meegan, & Strough (2003) used vacation decision-making and social dilemmas for research on the same object. However, little research on older couples in context of complex cognitive problem solving that requires multiple fundamental skills when collaborating as a dyad has been done so far. A reason for this might be that for planning, learning, memory, retrieval and decision making always separate paradigms were used, and that adequate paradigms to examine complex dyadic problem solving are lacking. Thus, this thesis had two main goals: First, to further develop and adapt existing problem solving task to allow examining complex dyadic problem solving in old dydas with a wide range of individual ability levels. Second, to examine the feasability and validity of a range of dyadic problem solving tasks to determine how the complementary management of individual skill application may optimize individual's problem solving performance. To achieve these goals, this thesis embodies four individual but closely related chapters concerning the testing of cognitive problem solving of old dyads. Two new paradigms were developed for the examination of the problem solving task in old dyads.

1.1 Cognitive problem solving

Cognitive problem solving occurs in a broad spectrum of situations in all realms of our lives. Things like keeping appointments in mind, remembering how kitchen or other gadgets work or how to make them work, knowing where to get a specific book or an article if necessary, being able to plan a trip or help out in certain situations are all everyday problems that we

normally are able to master without putting much thought to it. In case more serious problems arise from one or more realms, and we believe we cannot solve them sufficiently on our own behalf, we have to change our strategy and seek help from other available sources. Problem solving may also take place in groups, which is often seen in academics, science, medicine, business, and including all social fields. In this thesis the focus lies on dyadic problem solving and is concentrated on couples over 60 years of age. Over a human lifespan, problem solving strategies may change. Aging as such will contribute to changes in problem solving since extended experience in social, emotional, and interpersonal matters will influence the perspective on problems, and problem solving may be approached differently in later years of human lives. Couples who walk through life as partners most probably make problem solving and everyday problem solving into a joint venture, at least in certain domains of their shared lives. Surprisingly, however, dyadic problem solving of old couples so far is rarely examined although it will likely become extremely important due to the rising numbers of old and very old couples.

1.2 Development of life expectancy of individuals and couples

In fact, life expectancy of both genders is constantly on the rise in the Western World (Bundesamt für Statistik, Schweiz 2005; CIA The World Fact Book 2008; Mikrozensus 2006, Deutschland; Statistical Abstract of the United States, 2000). In Germany, for instance, for the year 2010 the estimated population age 60 and older is 26.6 %, for 2020 it is 31.7 %, and for 2050 it is 44.4 % (DIW Berlin). Also in Germany, the life expectancy in 2005 for men was 75.7, for women 81.8 years and 18.9% of the population was over 65 years of age. For Switzerland in 2005 life expectancy were 77.6 for men and 83.4 years for women. The population over 65 years of age was 15.4 %. In the European Union in 2005 life expectancy for men was 75.1 and for women 81.6 years, and the population over 65 years of age was 16.8%. In the United States of America life expectancy in 2005 for men was 74.9 and for women 80.7

years, and the population over 65 years of age was 12.4%. These numbers clearly show that in the Western world the population over 65 years of age is growing constantly and will have a growing impact on social and economical issues in the future.

In this dissertation couples of 60 years of age and older are in the focus. But how is "old" for people actually defined? According to the World Health Organization, most developed world countries have accepted the chronological age of 65 years as a definition for an 'elderly' or 'older' person but the UN agreed cutoff is 60+ years to refer to the "older population". Although there are commonly used definitions of old age (young-old = 65-74 years; old = 75-84 years; old-old 85-100+ years; (Martin & Kliegel, 2008), there is no general agreement on the age at which a person becomes old. The common use of chronological age to mark the threshold of old age assumes equivalence with biological age, yet at the same time, it is generally accepted that these two are not necessarily synonymous (WHO, 2008). According to the mentioned statistical numbers, Western societies have large populations over age 60. Consequently they include large numbers of couples that are 60 years of age and beyond.

Couples over age 60 and further may have to solve problems to a larger extent than younger couples due to age-related increases in problem situations. It may affect the solving of everyday problems or more complex problems concerning social, economical, technological or health-related issues. The questions of interest that arise here are: How do these old couples perform when problem solving is necessary? Do they collaborate well or are they better off as individuals during problem solving? Is joint problem solving of old couples perhaps an advantage that can lead to longer independence of the dyad or is it rather destructive than productive for two old people? Since cognitive problem solving strongly involves memory, can collaboration on a memory task of two people knowing each other for a long time achieve more than if an individual worked on the task alone? If so, how combine old couples their memories and how well do they perform together?

1.3 State of research on old dyads

Ideally, to examine cognitive problem solving of old dyads a complex experimental paradigm requiring the orchestration of complementary fundamental skills would be used. An attempt in this direction was made within the Berlin wisdom paradigm (Staudinger & Baltes, 1996) when focusing on the relation between everyday problem solving and professional expertise. In addition, a social-interactive wisdom paradigm was developed that gives credit to both individual and interactive cognition in their respective contributions to the activation of wisdom-related knowledge. However, this was still only focused on wisdom-related knowledge application.

1.4 Need for paradigms to study dyadic cognition

When testing old dyads' cognitive problem solving including learning, memory and decision making, often paradigms like a shopping list memorization task, a vacation planning task and/or a story recall task have been used to examine how many items or facts an old couple is able to retrieve. Of course this is a combined task of the dyad, but the collaboration may quite vary. Some partners may collaborate equally, others may leave it up to the more engaged and stronger partner and go along with his/her inputs. In this scenario, the sum of the input of the two partners are seen as the result the dyad could obtain. This approach often does not take into account if there is equal collaboration between the two partners. Still, a more complex paradigm might lead to a more intense collaboration between the two partners and might show better what a dyad can accomplish. The paradigm, introduced in chapter 1 and 2 of this thesis exemplifies this. What is more, it might be of great advantage to have more complex paradigms that still are tailored for testing old dyads' cognitive problem solving in general and in dyadic memory and collaboration in particular. Preferably such a paradigm would be constructed in a way that it induces the collaboration of the two partners automatically because in this respect the results can be seen as a product of the dyad (and not as the added individual inputs of the partners of a

dyad) that is actually the focus of interest. With this in mind, the Word Combination Test for Couples (WCTC) was developed. It is a verbal test and fulfils the requirement of automatically induced collaboration. It has a simple version (WCTC-S) introduced in chapter 3 and an advanced version (WCTC-A) that is presented in chapter 4.These two new paradigms are a small step in the direction of finding or creating practicable paradigms for testing old dyads. Future research will then have to observe old dyads' cognitive problem solving capabilities and its development.

2 Introducing a computerized paradigm to test the cognitive problem solving ability of old couples

2.1 Introduction

In the next decades, the number of couples aged over 65 will rise due to higher life expectancy of both genders (Bundesamt für Statistik, Schweiz 2005; Mikrozensus 2006, Deutschland; Statistical Abstract of the United States, 2000). These couples will have to master tasks, responsibilities, and problems of their daily lives jointly, often up to very old age. Problems to solve may arise through personal health changes in one or both partners. Social changes, like children and grandchildren moving away or neighbors and friends not being available any further due to death or nursing home residency, may also require dyadic problem solving skills to adapt to the new living situation. Technological changes in household machines, ticket machines for public transportation and the increase of more computerized tasks in everyday life need to be mastered as well. Financial changes for the elderly may also give some problems to solve for an aging couple. To master these problems in their daily life, older couples need not only cooperation and respect for each other, but also the willingness to complement each other when necessary. Thus, dyadic cognitive problem solving skills will increasingly be required to solve everyday problems of old individuals.

Problem solving is considered the most complex of all intellectual functions and has been defined as higher-order cognitive process that requires the modulation and control of more routine or fundamental skills (Goldstein & Levin, 1987). Fundamental skills such as planning, learning, memory, retrieval and decision-making (Canestrari, 1963; Cerella, Poon, & Fozard, 1982; Geraerts, Marcoen, & Verhaegen, 2000; Salthouse, 1993, 1994a) are part of cognitive problem solving. Since in everyday life it is obvious that using these fundamental skills, i.e., one or all of them, to solve problems, they have been investigated, mostly separately, when testing young and old individuals during problem solving. The results gave answers to the question how well young and old individuals use their fundamental skills when solving

problems. But what is known about when these fundamental skills are used in dyadic cognitive problem solving?

Dyadic planning has been investigated through errand planning by Berg, Johnson, Meegan, & Strough, 2003, and Margrett & Marsiske, 2002 (for a review see Martin & Wight, 2008). Dyadic memory was examined through story recall, vacation description, and item recall from a shopping list (Dixon & Gould, 1998; Gould, Lee, & Dixon, 1991; Gould & Dixon 1993; Ross, Spencer, Linardatos, Lam, & Perunovic, 2004). Staudinger & Baltes (1996), reviewed dyadic decision making through wisdom paradigm, while Margrett & Marsiske (2002), and Berg, Johnson, Meegan, & Strough (2003), used vacation decision-making and social dilemmas for research on the same object. However, little research on older couples in context of complex cognitive problem solving when collaborating as a dyad has been done so far. A reason for this might be that for planning, learning, memory, retrieval and decision making always separate paradigms were used.

This study had two main goals: First, adapt existing problem solving task to allow examining problem solving performance in old dyads. We needed to ensure that the paradigm would be suitable to test the individual and dyadic ability to solve cognitive problems, i.e., to orchestrate fundamental skills of learning, planning, encoding, retrieval, and reasoning. Further, it had to be feasible to use with old people. Eventually, we used an adapted version of a computer game that allows for repeated testing, makes high demands on memory and reasoning, can be used to examine individual and dyadic performance, and is generally applicable across adulthood and old age. Our hypothesis was that it could be demonstrated that with adequate instructions this paradigm can be used with old adults.

Second, we wanted to explore how well old dyads versus old individuals would perform on this task. The existing literature suggests that groups of two or more individuals always recall more than an individual (Basden, Basden, Bryner, & Thomas, 1997; Meudell, Hitch, & Boyle, 1995; Meudell, Hitch, & Kirby, 1992; Weldon & Bellinger, 1997). But the authors also mention that due to

collaborative inhibition real pairs compared to nominal pairs recall less (Andersson & Rönnberg, 1995; Finlay, Hitch, & Meudell, 2000) whereas Basden et al. (2000) state that nominal pairs sometimes exhibit no difference from real pairs. However, we hypothesized that in old adults living together, knowing each other for a long time and maybe being aware of each other's traits, limits and strengths, the advantages of collaboration may outweigh the costs of managing the collaboration. Thus, we expected that old dyads perform at least as well or even better than old individuals on this task in a laboratory setting. Therefore, in this study examining complex cognitive problem solving, the following questions were of importance: How well will older couples manage their complex cognitive problem solving as a dyad? Is it possible that two old adults living together for a long time and knowing each other's strengths and weaknesses in many realms, can achieve better results when collaborating in cognitive problem solving than each individual within the pair? Or does this closeness and long routine in many tasks rather impair complex cognitive problem solving of couples to the benefit of the individual?

To answer these questions, a feasible and complex problem-solving paradigm was needed. That means it had to include learning, planning, retrieving and in particular memorizing and reasoning components to allow examining dyadic cognitive problem solving within an experimental setting. A computerized task (see below) was used because it seemed to fulfill the requirements for a complex paradigm. It also seemed equally suited for testing couples and individuals so that the performance of individuals and couples could be compared.

2.2 Method

2.2.1 Participants

A convenience sample of sixteen couples volunteered to participate in the study. Two couples had to be excluded from the analysis since in one couple the woman could not read the instruction booklet. In the second couple, the female participant refused to participate after

reading the instruction booklet. The remaining 14 couples had lived together or had been married and lived together for at least five years. The age of the participants was between 60 and 83 years. The mean age for women was 70.9 years (SD = 6.3) and for men 75.3 years (SD = 6.4). The mean of couples' age was 73.1 years (SD = 6.6), and the mean age difference within couples was 4.4 years (SD = .09). All participants were healthy, had normal or corrected eyesight and good hearing. Participants' formal education was in the range of 8 to 13 years, with 9.8 years for women (SD = 1.3), 11.1 for men (SD = 1.5), and 10.4 years for couples (SD = 0.9).

2.2.2 Materials

We used a computerized game task in which participants had to infer the location of hidden points (in this computer game called atoms) in a blocked 9x9 matrix. According to the rules of this computer game, participants had to infer the locations by remembering the entrance and exit points of light rays that were supposedly shot into the box and by applying a set of rules how light rays were reflected or deflected by the atoms. Two booklets with the description of the paradigm were used (see Figure A) so that both partners of a couple could study them at the same time. The booklets were available in a German and an English version. The first thing all participants had to do was to study the booklet with the instructions in detail. After completing the instruction, individuals were tested on a computer with a 17" color screen using an adapted version of the computer game "BBX 21" (originally developed by Eric Solomon and mentioned in Johnson & Krems 2001). Only the entrance and exit points of the light rays, and only one pair at a time, were visible (Fig. A4-b); the path of the light rays was not visible. Each atom had an imaginable field of influence that was also invisible to the subjects (see Fig. A1-c). All subjects were thoroughly trained on the rules how light rays interacted with the atoms, and their fields of influence. Approximately 90 minutes of introduction were necessary until participants fully understood the instruction. Further detailed instruction of this computer game is available in Figure A. The task includes strong

elements of memory tasks since several indispensable rules of the computer game have to be correctly memorized (e.g. page 12 to 15, Figure A1-a to A4-a), and spatial memory is required to remember the entrance and exit points of light rays on the grid of the game (e.g., Fig. A5-c). Reasoning skills are required when participants have to determine where exactly to mark the place of the atom in consideration of the rules and the light ray entrance and exit point information acquired while working on the task (e.g., see Fig. A7-b).

Figure A: *Computerized Problem Solving Task*

Fig. A1-a

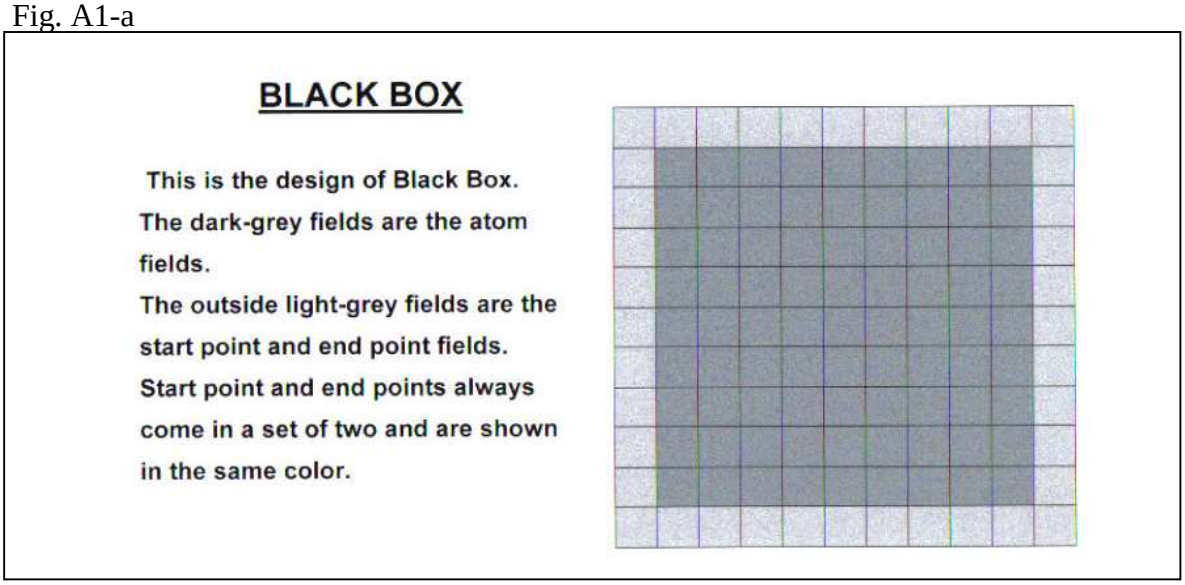


Fig. A1-b

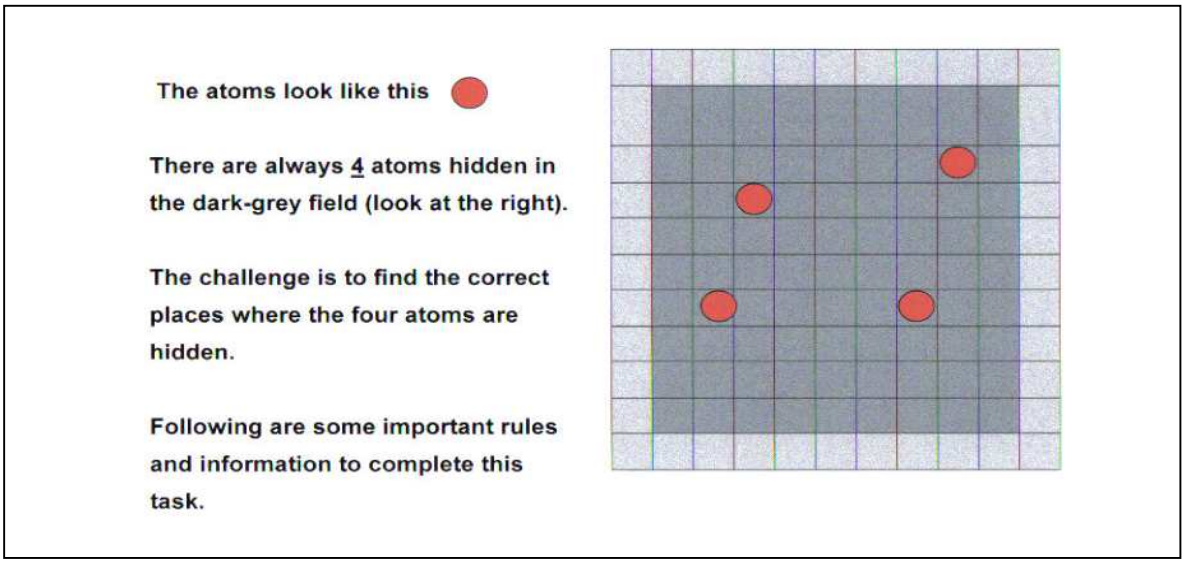


Fig. A1-c

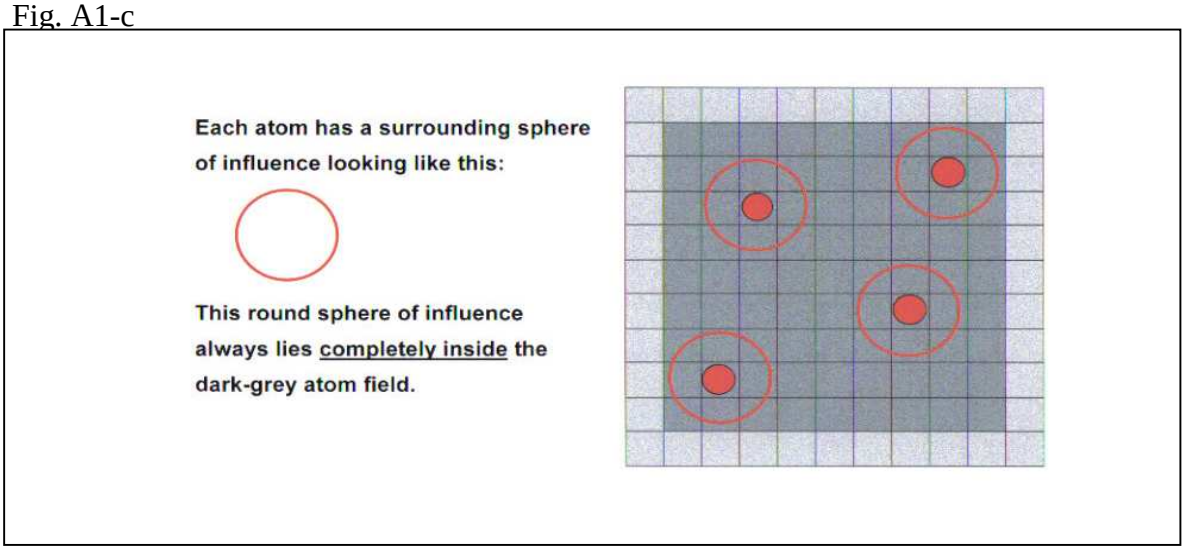


Fig. A2-a

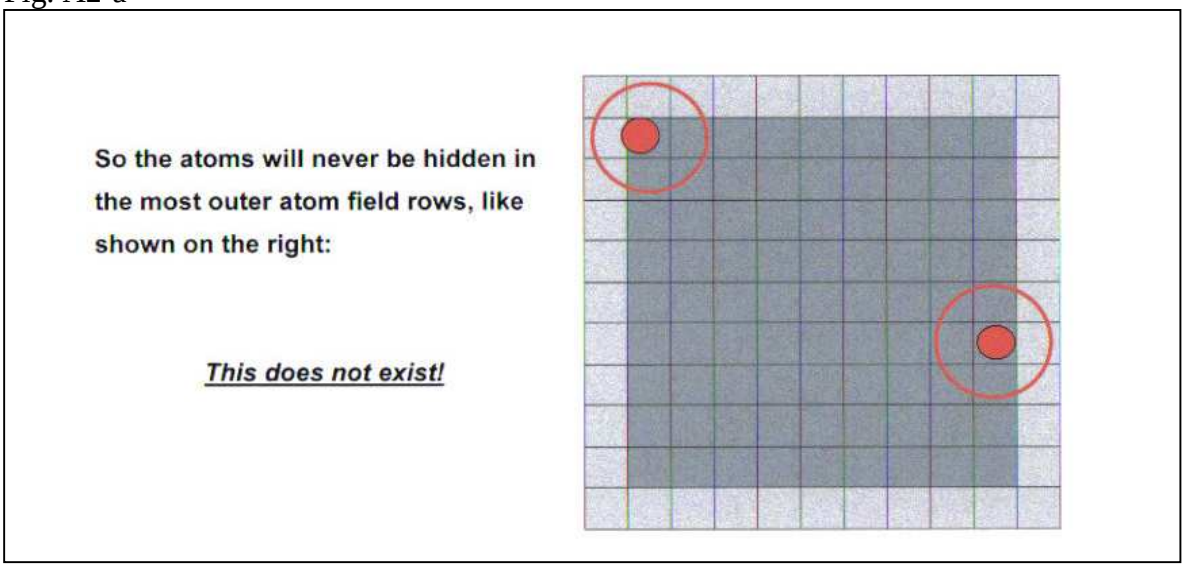


Fig. A 2-b

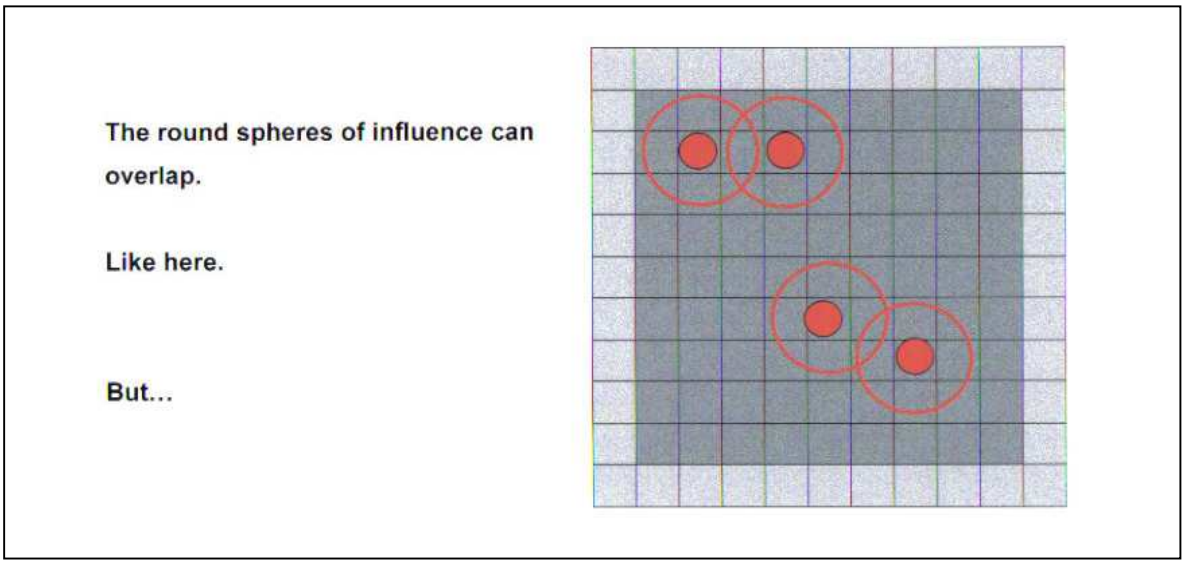


Fig. A2-c

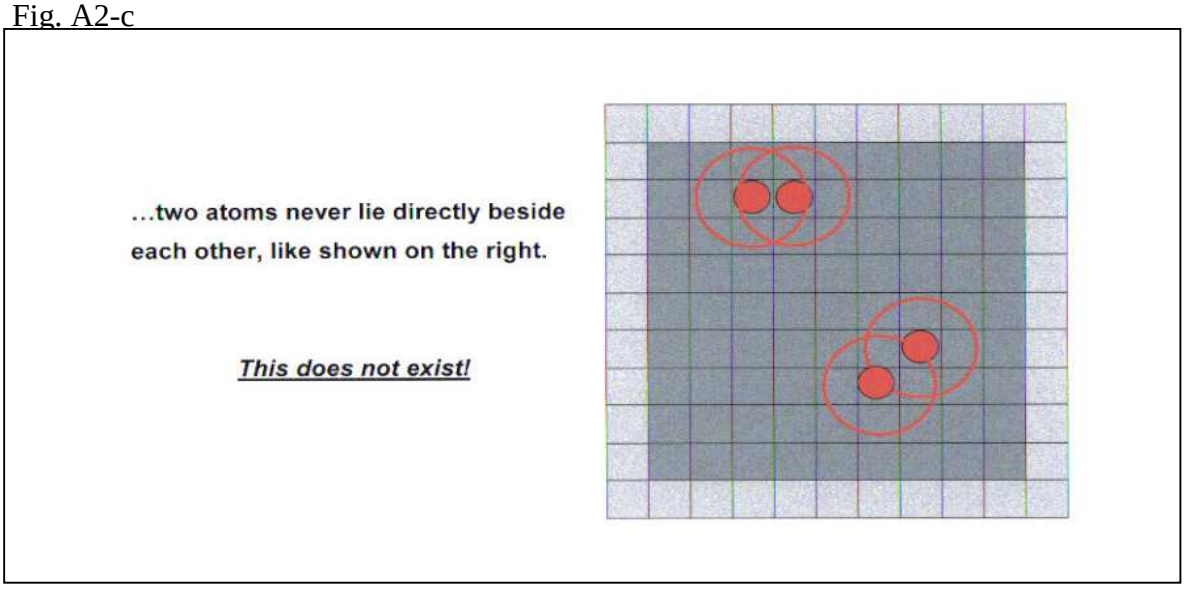


Fig. A3-a

With the help of light rays it has to be determined where the atoms are situated.
The light rays look like this

In the light-grey fields you can see the start- and end-points of the light rays.
It makes no difference if the light ray moves from up to down or the opposite direction.
The same is valid from left to right or right to left.

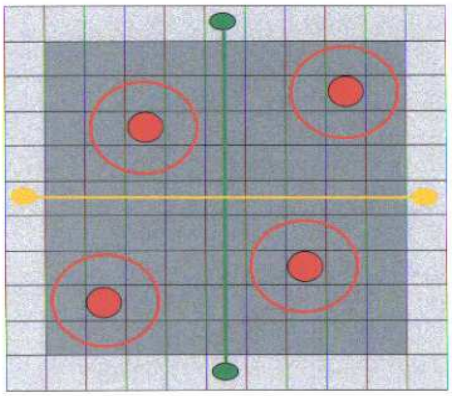


Fig. A3-b

In the actual game the light rays will not be seen, only the start- and end-points are visible. So a pair of same color points is visible.

A light ray can unopposed run through the dark-grey atom field, when no atom and no sphere of influence is in its way.

Like on the right.

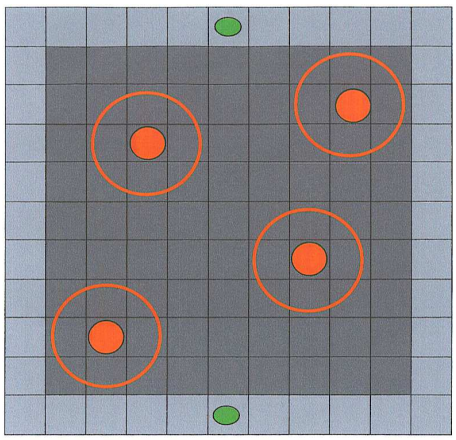


Fig. A3-c

When a light ray directly hits an atom like here, it is swallowed by the atom.

Then there is only one start-point in the light-grey starting fields. The light ray will not exit any more.

(Will not happen in test)

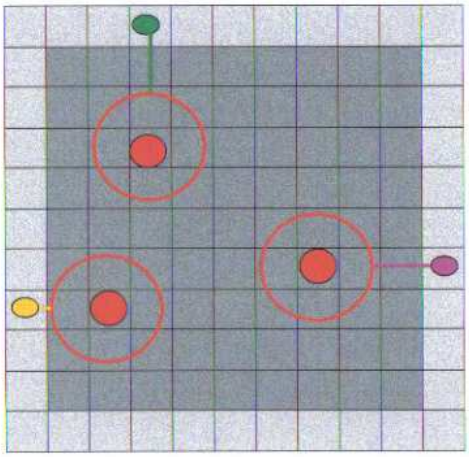


Fig. A4-a

If the light ray hits the sphere of influence of an atom in the areas shown, then it will be deflected by 90 degrees and come out around the corner. Through this it can be figured out where the atom is situated.

Seen on the right

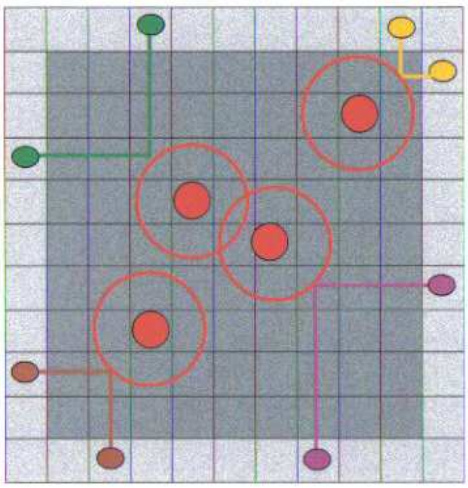


Fig. A4-b

Guess where an atom is hidden in this case!

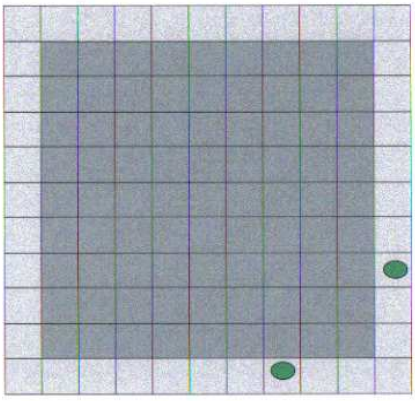


Fig. A4-c

The atom lies in the dark-grey atom field diagonal outside the deflection point of the light ray.

Please try again with the yellow, purple and red pairs.

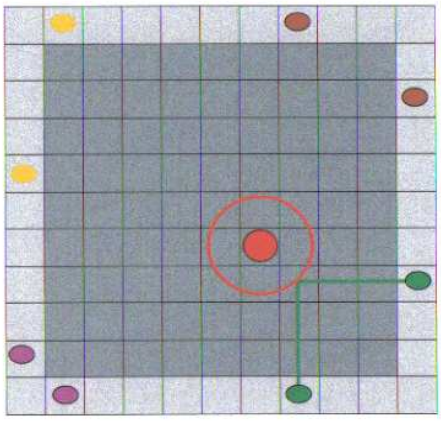


Fig. A5-a

This is the complete correct view.

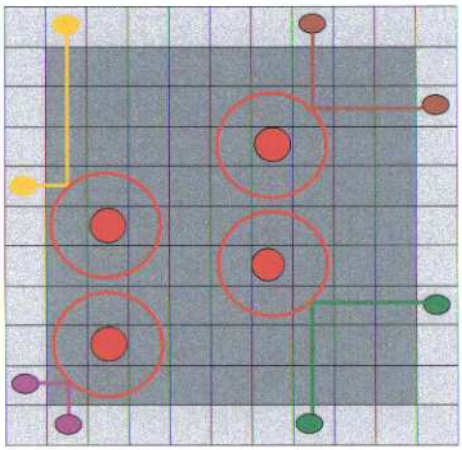


Fig. A5-b

To mark an atom, the small dark-grey field has to be clicked. A black cross appears. The "atom cross" cannot be changed.
To get the next pair of start- and end-points "Next" on the screen has to be clicked (not seen here). After four pairs have appeared and hopefully four crosses were set, "Next try" (not seen here) has to be clicked and a new table where 4 new atoms are hidden will appear.
Totally 9 tables, each with four hidden atoms, will appear in the test.

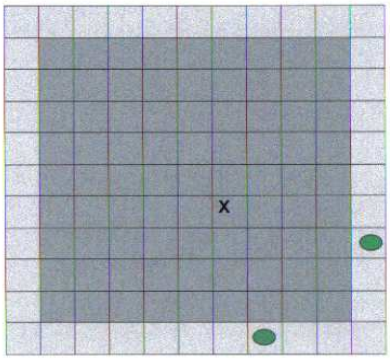


Fig. A5-c

When one does not want to click the X for the atom but want to see the next colored pair, "Next" has to be clicked. In the actual test then the next colored pair appears but the pair before disappears and it has to be remembered by heart where it was sitting in order to be able to click the X later. This can make the test game pretty challenging.
(However, there will be a training test before the counting test where all pairs after clicking "Next" stay visible to the participants so they can learn during the training).

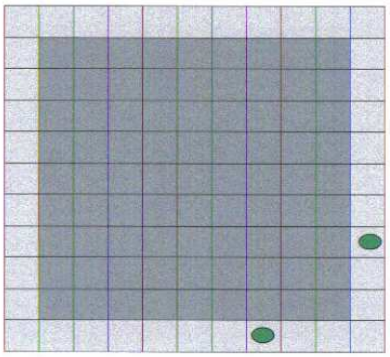


Fig. A6-a

Example of training set:

All X for the pairs are set correctly
except for the yellow pair

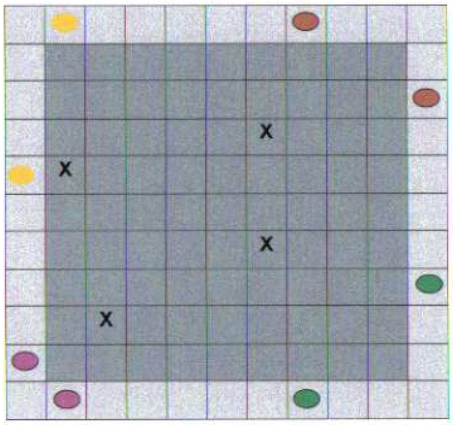


Fig. A6-b

This is the explanation!

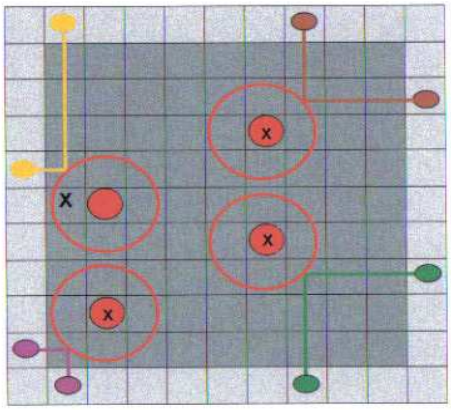


Fig. A6-c

The following scenario is also possible:
The light ray deflects 90 degrees twice.

- Start- and end-point of the green, purple and yellow pairs appear beside each other.
- The corresponding atoms lie two rows further apart than the start- and end-point of the pair.

OBSERVE THIS CLOSELY!

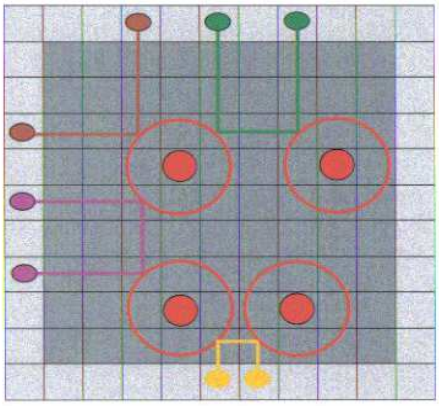


Fig. A7-a

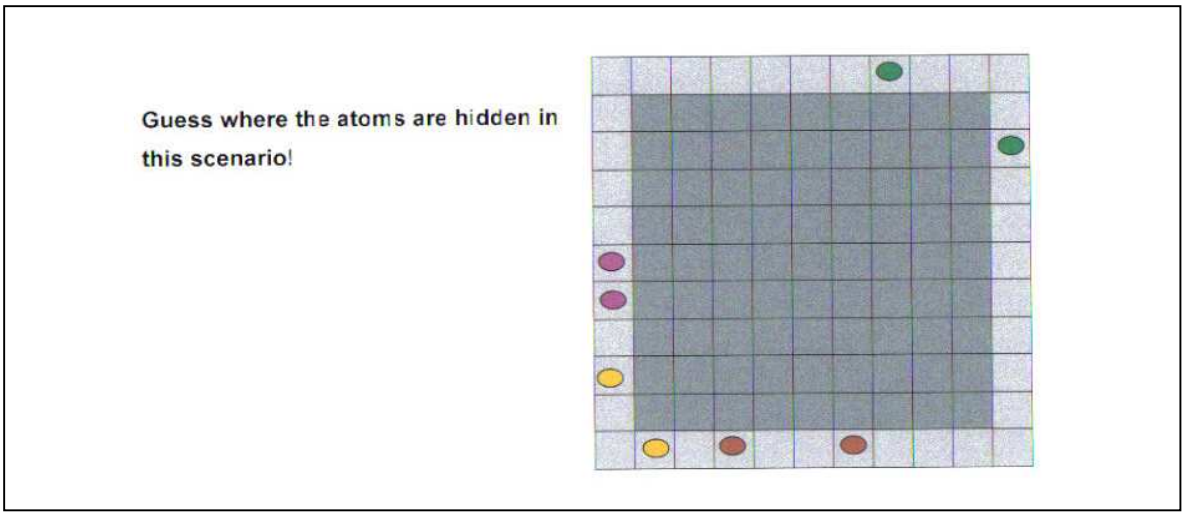


Fig. A7-b

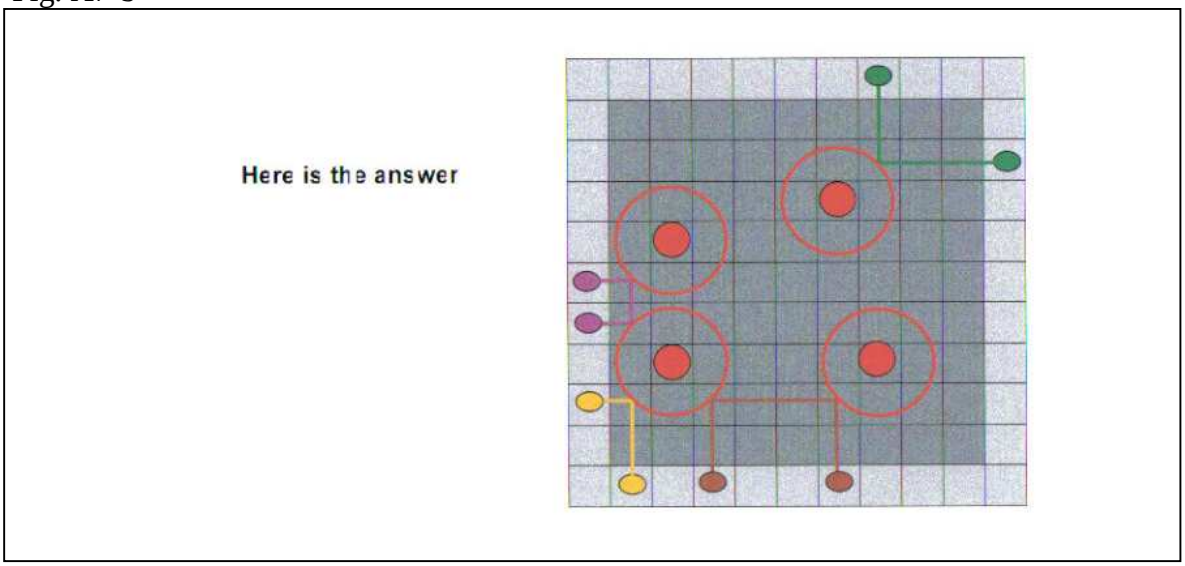
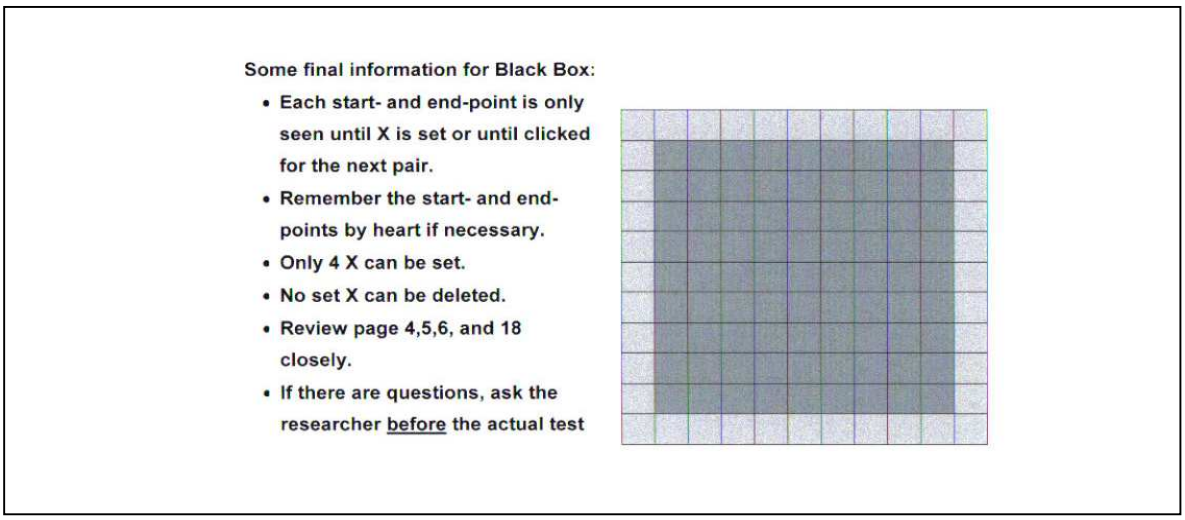


Fig. A7-c

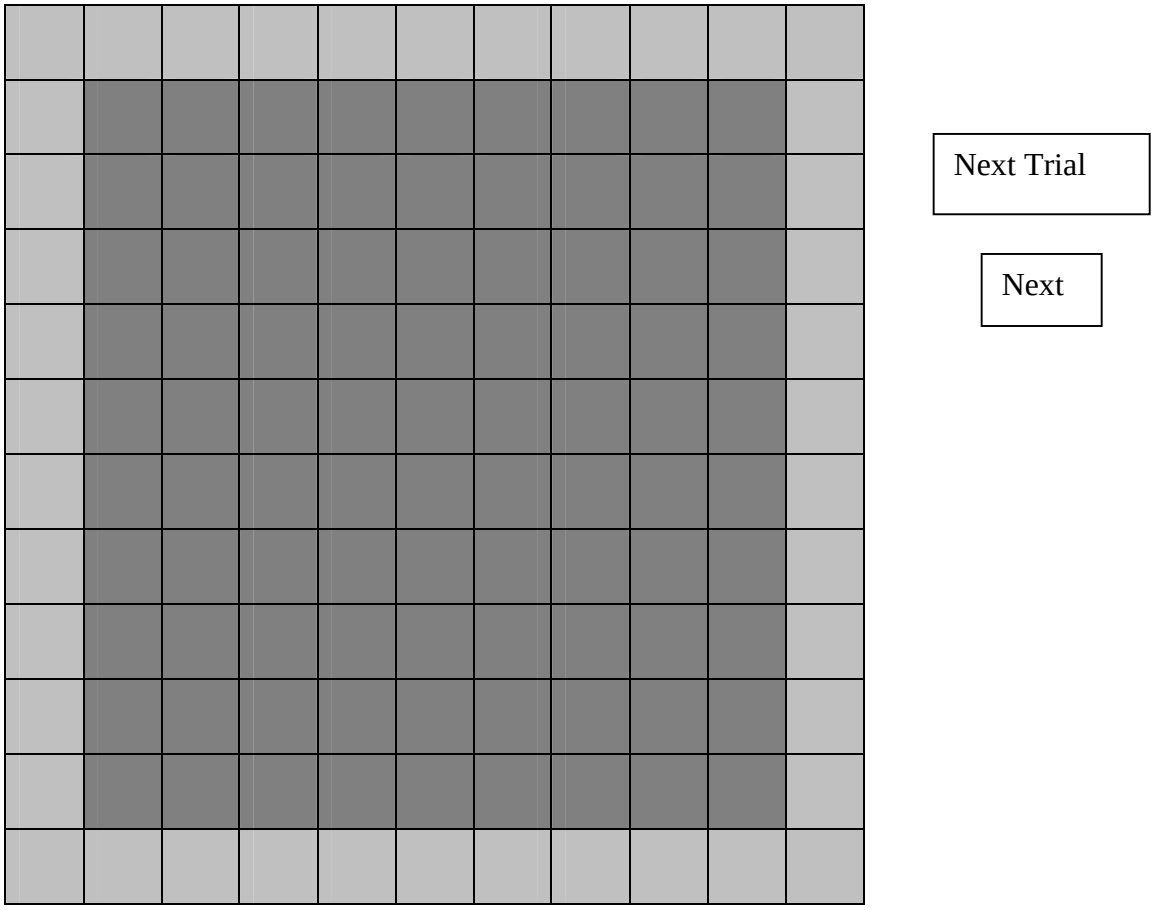


2.2.3 Procedure

Participants could chose to be tested in their own home or at the researcher's office, wherever they felt more comfortable (Lazarus, 1991). Time scheduled for instructing and testing one couple was three hours. At first participants had to read the instruction booklet and were instructed on the paradigm procedures followed by information about the computer (see Fig. B). Questions concerning the program could be asked and were answered by the researcher. Everybody had a choice to operate the computer's integrated mouse or an external mouse that was connected to the laptop. After about 90 minutes of instruction every subject had the opportunity to run two practice trials on the computer in order to become familiar with the tasks and be ready for the ultimate test. During these two test-runs only the participant and the researcher were in the room. Questions were allowed and answered by the researcher.

The actual test then showed nine matrices, each with four hidden atoms, which the subjects had to find by interpretation of the entry- and exit-points of the light rays. Each correctly detected atom was counted by the computer and marked as one score. Maximum scores for individuals and couples consequently were 36. Pencil and paper for notes were not allowed. The 17" screen was not allowed to be touched. No help from the researcher was given during the scoring test. The single participants and later the couples were left alone during the scoring tests. Couples could talk to each other during the scoring test as much as they needed or wanted to. For this test, all participants were given 10 minutes of time. Female subjects were tested first, male subjects followed. After that, couples were tested. This provided the possibility to compare individuals' and couples' scores later on. During a short debriefing, the results of their sessions were shown to the participating couples and they were interviewed about their liking of the test.

Figure B: *Illustration and Description of Computer Screen Before couples Start the Test*



At the beginning of the test to be scored, the researcher brings up the above screen on the computer. Participants start and click with mouse “Next Trial” and then “Next”. Two points (start and end point) become visible in the light grey area (see Fig. A4-b). Participants now mark the atom (by mouse click in one of the dark grey fields) where they believe the atom is hidden (see Fig. A5-b). Participants click “Next” and two new points appear. Go on like before. After four times of clicking “Next” and placing the atom, the first game is over. Participants now click “Next Trial” and “Next“, and the second game starts. In each game four atoms have to be clicked. Overall nine games are played, so 36 atoms are hidden. Each correct detected atom counts as one score. Erasing atoms (wrong or correct ones) is not possible. No screen touching is allowed.

2.3 Results

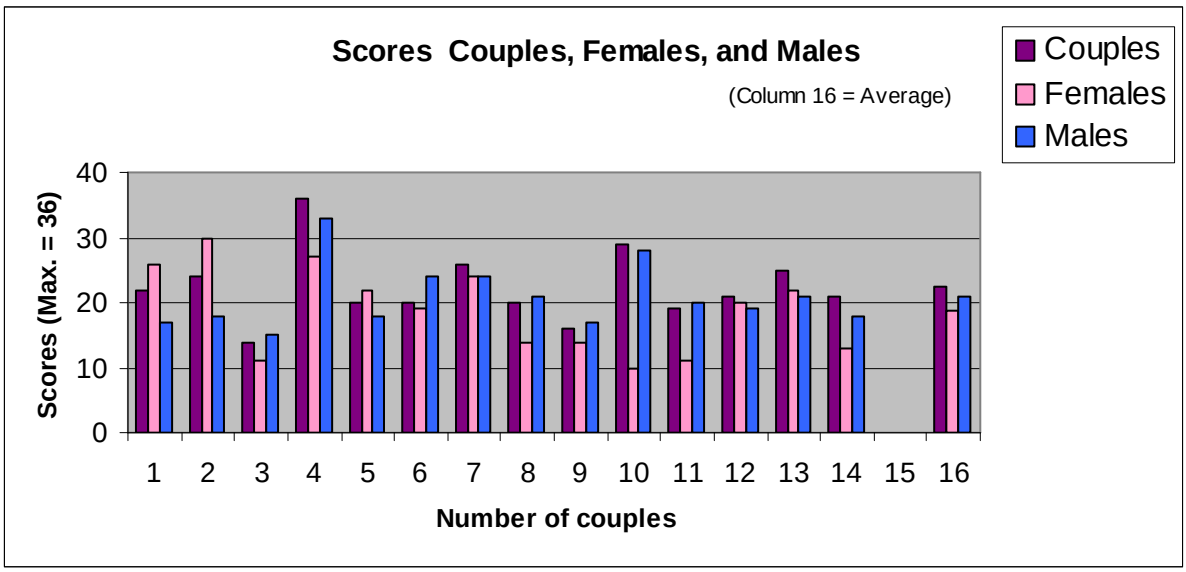
On the mean level women scored 18.8, SD = 6.6; men scored 20.9, SD = 4.9; Couples scored 22.4, SD = 5.5.

Chi-square (χ^2 (df = 13) = 22.36, on the .05 level. To be significant on the .05 level chi-square has to be greater or equal to 22.36. The difference between couples (M = 22.4, SD = 5.5) and women (M = 18.8, SD = 6.6) was not significant (χ^2 =13.286); the difference between couples (M = 22.4, SD = 5.5) and men (M = 20.9, SD = 4.9) was not significant (χ^2 =2. 330); the difference between men (M = 20.9, SD = 4.9) and women (M = 18.8, SD = 6.6) was not significant (χ^2 =19.202).

Table 1: *Scores and Data of Couples, Women and Men*

Number	Couples	Women	Men	Age F/M/C	Mar-ried	Living togeth.	Edu.School Years F/M/C
	Score	Score	Score	F M C	Years	Years	Approx. years
1	22	26	17	67 / 72 69.5	41		F M C
2	24	30	18	60 / 64 62	40		9 10 10
3	14	11	15	79 / 83 81		10	9 12 9.5
4	36	27	33	62 / 63 62.5	32		10 9 10.5
5	20	22	18	69 / 74 71.5	15		9 10 9.5
6	20	19	24	71 / 80 75.5	50		9 10 9.5
7	26	24	24	70 / 76 73	38		9 12 9.5
8	20	14	21	75 / 77 76	27		12 12 10.5
9	16	14	17	80 / 78 79	17		9 9 12
10	29	10	28	69 / 76 72.5	48		10 13 11.5
11	19	11	20	78 / 82 80		7	10 12 11
12	21	20	19	77 / 77 77	53		9 10 9.5
13	25	22	21	65 /69 67	29		13 13 13
14	21	13	18	70 / 83 76.5	49		9 13 11
Mean	*22.36*	*18.8*	*20.9*	*70.9 / 75.3 73.1*	*36.6*	*8.5*	*9.78 11.07 10.4*
SD	*5.51*	*6.64*	*4.89*	6.26/ 6.39 6.60	*12.8*	*2.12*	*1.25 1.49 0.91*
Total	313	263	293				

Figure C: Graphic of Scores from Table 1



Looking at the raw numbers, the result was that the old couples, in all 14 cases, scored better than the individual with the lowest score within the couple. That indicated that the weakest individual always could profit when collaborating with her/his long-time partner. This supports earlier findings from Baltes & Staudinger (1996) who had used wisdom tasks when examining dyadic decision-making during dyadic performance. The better scoring individual in all but one case scored lower when collaborating with a weaker partner, but that loss could be seen in favour of the more dyad-balanced outcome. Looking at the mean level scores of all participating individuals and couples, couples out-scored even both individuals within the couple. Taking this in context of the cognitive problem solving ability, it seemed to be the case that older couples could become quite efficient through collaboration (Dixon, Fox, Threvithick, & Brundin, 1997). Since they knew each other for a long time and perhaps might be aware of each other's thinking patterns (Baltes & Staudinger, 1996; Wegner, Erber, & Raymond, 1991), they seemed to be able to develop a dyadic cognitive problem solving power that exceeded the capability of the older individual.

2.3.1 Paradigm practicability

The complex individual and dyadic problem solving paradigm was designed to measure how well dyads managed the orchestration of individual memory and reasoning abilities in order to achieve an optimal problem solving performance within a dyadic testing situation. Memory was needed to acquire the rules, the knowledge about operating the testing equipment, and when having to remember entrance and exit points of light rays. Reasoning was required to infer the correct solutions. However, the complexity of the experimental paradigm might also have compromised the selection of participants or lead to differences between individuals and dyads how they actually solved the task. Therefore, we observed throughout the experimental study how the task could be further optimised in order to use with old individuals and dyads.

2.3.2 Observed behavioural results

When recruiting older couples to participate in this research, it became obvious that they seemed to be more hesitant in joining an experiment like this than older individuals. The decision to participate in a study about couples as such, and specifically concerning their cognitive abilities, seemed to provoke in most of them some unpleasant or at least suspicious feelings. Many older couples viewed their bond to each other as a very private issue, and they told the researcher so when being asked why they did not want to participate. They argued that a participation in a study about cognitive problem solving could bring difficulties like blaming each other for certain mistakes or behaviours subsequently to the test, which then consequently might result in a disturbance of their relationship, which of course they wanted to avoid. It seems, even when according to Lawton (1989), emotions are more controlled in old age, couples were very concerned about their emotional well being as a couple. Women did hesitate less than men when asked to participate in this research. Men were more concerned than women that no personal data or names would appear in public. They often wanted to be reassured by the researcher that no names and birth dates would made be public

before they started the test. During the introduction to the paradigm, female participants asked more questions than their male partners. Before working as a dyad, male participants dominated in deciding who would operate the mouse and who should try to remember certain constellations on the matrix. They saw themselves and behaved as leaders (Bandura & Cervone, 1986) even when during the tasks, shown in the pre-tests, women were calmer and could remember some situations better. Male participants stated after the test that they were concerned to get through all 9 matrices in the ten given minutes of time. Most women simply did not mention time but told the researcher, memorizing the start and end points of the light rays was quite a challenge for them. All couples seemed to be relieved when finished with the test and had little interest to repeat it, in case this would have been possible. This was a different behaviour in comparison to younger couples age 30 to 45. In a pilot study at the University of Zurich in 2005, the same paradigm was used to compare cognitive problem solving in young (30-35 years of age) and old couples (60 – 90 years of age). Here young couples reported to have enjoyed being tested with this paradigm and would have volunteered to repeat a session with this paradigm, no matter how well they scored in their test. Old couples were not interested to do so even when they had top scores. Older couples seemed to have very high goals when working together and showed quite some disappointment when their scores did not meet their expectation, which always was focused on the maximum number of points. This was the case in the present study and also in the pilot study from 2005.

2.4 Discussion

Dyadic cognitive problem solving is a complex task, which is necessary for couples to manage their combined lives. However, different levels of individual cognitive problem solving abilities have to be expected. Thus, we have introduced a paradigm to determine how well older couples perform in comparison of the individuals within the couple when they work on a complex problem solving task. Based on our findings, we believe that we found

such a paradigm since it included important portions of memory and reasoning abilities in a complex task environment.

Limitations of exploratory studies with very few participants and the use of convenience samples in studying dyadic problem solving have to be acknowledged. However, the main focus of this study was to present an experimental paradigm that could be used to examine and compare individual and dyadic problem solving performance in a repeated measure design, and collect data on the possibilities to optimize the paradigm for future more widespread use in cognitive aging research. Although we cannot make strong claims about the generalizability of our findings to the general population of old couples, the finding that in all couples performance was best in the dyadic condition, and that couples performed all better than nominal pairs suggests that the basis for examining the complementary ways in which old individuals within couples perform problem solving, has been laid. In fact, the results in our sample showed that old couples always out scored the weakest individual within the couple. Looking at the average of all 14 couples, couples outscored both individuals. This means old couples are very well able of complex cognitive problem solving, and both the weaker and the stronger individual of the couple always benefits. Evidently the tasks of the stronger and weaker individual complement one another and form a respectable dyadic task for complex cognitive problem solving, at least in our small sample. To verify this positive result concerning old couples, further research with a larger sample and more specified age groups (young-old, old, very old) is still needed.

The results show, that in terms of practicability, the design of the here used complex problem solving paradigm fulfilled the expectations concerning the implementation when cognitive problem solving tasks were tested in old individuals and dyads. In this respect this paradigm seems to be a feasible instrument for research in future times. Further, the positive results of this study where old couples and their individuals were tested on their cognitive problem solving abilities with this new paradigm, indicate that the implementation of this

paradigm in connection with old couples is suitable and eligible. Since this paradigm was also used successfully when younger dyads (age 30 to 35) were tested on their problem solving tasks, it seems to be an appropriate instrument for further research in a broad sense.

If results can be replicated across larger samples and age ranges, there are important implications that can be drawn from this study. For one, old couples, due to their stable dyadic skills in cognitive problem solving are able to solve everyday problems independently, i.e., without the help of individuals from outside the dyad. This is an important distinction from a view on cognitive aging that focuses on the individual where the complementary support from a spouse would already be seen as outside interference and, thus, sign of dependency. Even more generally speaking, research on the issue of dyadic problem solving may lead to old people being seen less as a burden to society (based on individual deficits in functioning) and more as a well functioning, big part of the society, that is able to solve its every day problems independently. Since in the future other models of aging than we know today may become relevant, it is possible that old couples, due to their good dyadic complex cognitive problem solving tasks, could become role models when it comes to dyadic cognitive problem solving skills, or at least, they can function as an excellent resource in many realms of future societies when dyadic cognitive problem solving is required.

3 Are Bridge players better dyadic problem solvers?

3.1 Introduction

As pointed out above, dyadic cognitive problem solving of old couples is of increasing importance in the coming years. Thus, good cognitive problem solving skills are an essential requirement for old couples in order to stay independent into very old age.

In chapter 2, a new paradigm was introduced to test old couples and their individuals on their abilities of cognitive problem solving in a laboratory setting. It was confirmed that the computerized game as paradigm allows for repeated testing, makes high demands on memory and reasoning, can be used to examine individual and dyadic performance, and is generally applicable to all ages. Having used this paradigm in our primary study, the idea arose to test couples with a special knowledge, and compare their scores with these of couples who lack this particular knowledge but are quite similar in age. Note that the argument so far has been based on the assumption that old couples are highly practiced in dyadic collaboration and that this acquired expertise should lead to an advantage when solving complex cognitive problems. However, it might also be the case that old couples have accumulated expertise in regulating their emotions (Lawton, Kleban, & Dean, (1993), or stress (Bodenmann, 1997), but hardly in solving cognitively demanding problems. Therefore, it remains an open question if specifically practicing dyadic collaboration in cognitively demanding tasks is particularly advantageous for solving cognitive problems in a laboratory environment. Since the card game Bridge is known as a very mind challenging card game (Engle & Bukstel, 1978; Ericsson & Kintsch, 1995; Ericsson, Patel, & Kintsch, 2000), we chose to test eight couples that played Bridge at least for five years. Bridge is a team card game, unlike chess, a board game, which is numerously mentioned in literature as the most mind-challenging game (e.g., Chase & Simon, 1973; Ericsson & Kintsch, 1995; Ericsson, Patel, & Kintsch, 2000; Gobet, 1998, 2000). Bridge is quite popular among older people, especially in English speaking countries (Encyclopedia Britannica, 2008). It is estimated that there are 50 million Bridge

players worldwide. More importantly, it has been used as a predictor of memory and cognitive performance in old adults in a number of studies (Berliner Alterstudie; Seattle Longitudinal Study; Simon & Chase, 1973). The card game Bridge is played by four people subdivided into two pairs, so partnership is one of the key factors of the game. Thus, it is similar to the computerized problem solving paradigm we used in study 1 in the sense that it also requires joint problem solving, good memory and reasoning skills, some mathematical skills, cooperation skills and social skills. Thus, one may hypothesize that when old couples played Bridge for at least five years, they probably have practiced essential skills required for performing optimally in the computerized problem solving task when tested with this paradigm than old couples who never played Bridge. Since there is no research to compare old Bridge playing couples with old couples that never played this game, we wanted to investigate this question using the paradigm introduced in chapter 1.

3.2 Method

3.2.1 Participants

A convenience sample of twenty couples who volunteered to participate in the study were approached by telephone request. Eight couples from social Bridge clubs in the Sun City area in the U.S.A. participated voluntarily. Twelve couples refused to participate after reading the instruction booklet and finding out that the computerized game is not showing any cards related to Bridge. The remaining 8 couples that participated had lived together or had been married and lived together for at least five years or longer. The age of the subjects was between 61 and 81 years. The mean age for women was 69.25 years (SD = 6.0) and for men 71.5 years (SD = 5.8). The mean of couples' age was 70.4 years (SD = 5.4). Mean age difference in couples was 4.8 years. All participants were healthy, had normal or corrected eyesight and good hearing. Participants' formal education were in the range of 8 to 13 years,

with 10.8 years for women (SD = 1.6), and 11.8 for men (SD = 1.3), and 11.3 years for couples (SD = 1.2).

3.2.2 Materials

Materials used here were the same as in Chapter 2; see Figures A and B.

We used the paradigm introduced in chapter 2 where participants had to infer the location of hidden points (in this computer game called atoms) in a blocked 9x9 matrix by remembering the entrance and exit points of light rays into the box applying a set of rules how light rays were reflected or deflected by the atoms. Two booklets with the description of the paradigm were used (see Fig. A) so that both partners of a couple could study them at the same time. Here the English version of the Booklet was used. The first thing all participants had to do was to study the booklet with the paradigm program in detail. Later, a computer with a screen size of 17" and in color, equipped with the same game program (BBX 21, originally developed by Eric Solomon and mentioned in Johnson & Krems 2001) was used for testing. In the computerized game, four points (here called atoms) were hidden in a box (9x9 matrix) and the participants' goal was to discover the atoms' locations when light rays were shot into the box. Only the entrance and exit points of the light rays, and only one pair at a time, were visible (see Fig. A4-b); the path of the light rays was not visible. Each atom had an imaginable field of influence that was also invisible to the subjects (see Fig. A1-c). All subjects were thoroughly trained on the rules how light rays interacted with the atoms, and their fields of influence. Approximately an hour and thirty minutes of introduction was necessary until participants fully understood the instruction. Further detailed instruction of this computer game is available under Figure A. The task includes strong elements of memory tasks concerning rules, (e.g. page 8 to14, Figure A1a to A4-a) and also of spatial memory (e.g. Fig. A5-c). Reasoning demands are challenged when to determine where exactly to mark

the place of the atom in consideration of rules and spatial memory in each single case (e.g. see Fig. A7-b).

3.2.3 Procedure

The procedure used here was the same as used in Chapter 2, 2.2.3.

3.3 Results

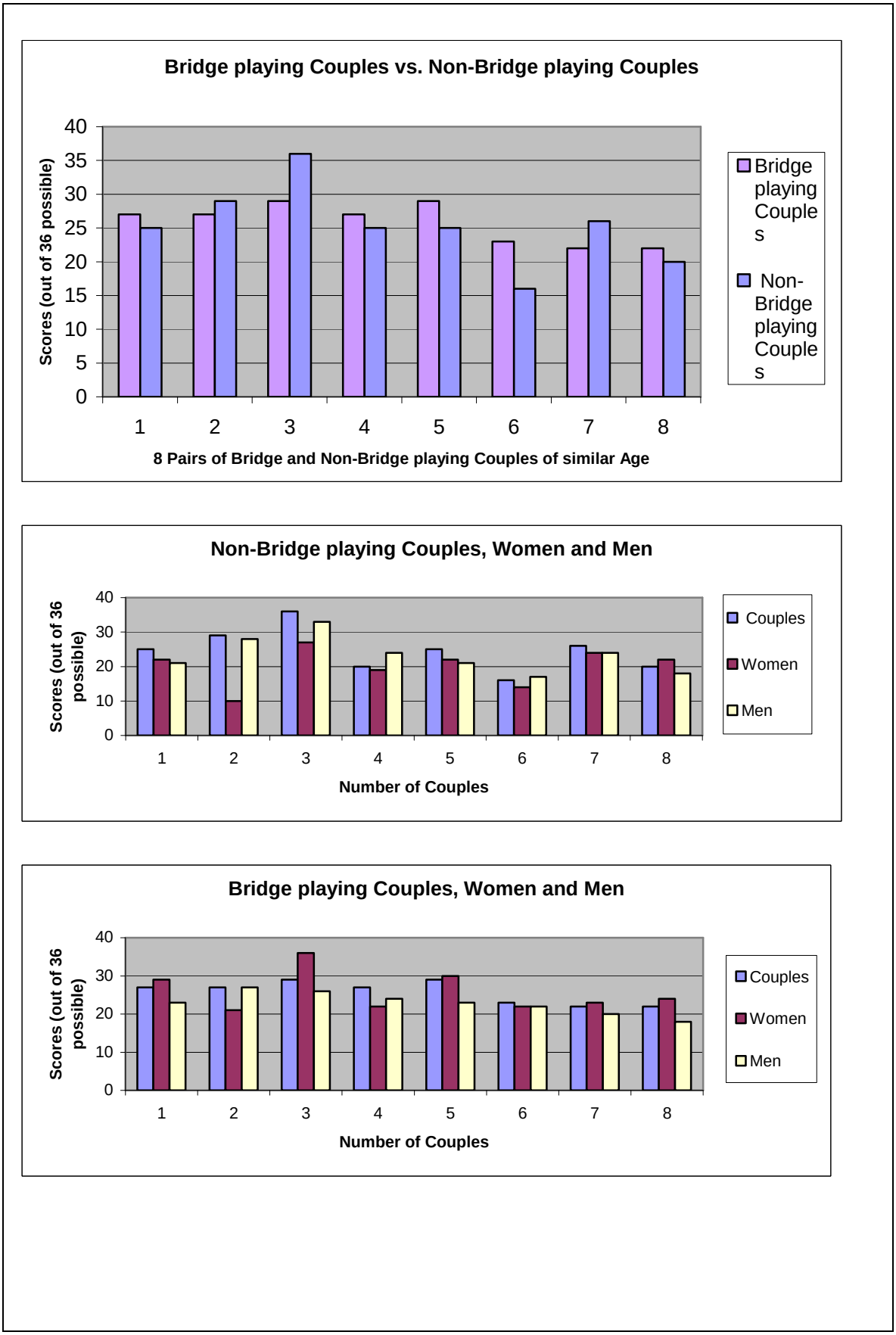
Table 2: *Scores and Data of Bridge playing Couples, Women and Men*

Number	**Couples**	**Women**	**Men**	**Age**		***Married***	**Edu. School Years**	
	Score	**Score**	**Score**	**Female/Male**	**Couple**	**Years**	**Female/Male**	**Couple**
1	27	29	23	61/70	65.5	34	8/10	9
2	27	21	27	75/69	72	41	10/12	11
3	29	36	26	65/62	63.5	38	12/13	12.5
4	27	22	24	76/75	75.5	49	10/13	11.5
5	29	30	23	64/67	65.5	15	12/12	12
6	23	22	22	77/81	79	41	10/11	10.5
7	22	23	20	69/75	72	29	12/13	12.5
8	22	24	18	67/73	70	35	13/10	11.5
Mean	*25.75*	*25.88*	*22.88*	*69.25/71.5*	*70.38*	*35.25*	*10.8/11.8*	*11.3*
SD	*2.97*	*5.28*	*2.95*	*6.07/5.81*	*5.36*	*10.1*	*1.64/1.28*	*1.16*
Total	206	207	183					

Table 3: *Scores and Data of Non-Bridge playing Couples, Women and Men*

Number	**Couples**	**Women**	**Men**	**Age**		**Married**	**Edu. School Years**	
	Score	**Score**	**Score**	**Female/Male**	**Couple**	**Years**	**Female/Male**	**Couple**
1	25	22	21	65/69	67	29	13/13	13
2	29	10	28	69/76	72.5	48	10/13	11.5
3	36	27	33	62/63	62.5	32	10/9	10.5
4	20	19	24	71/80	75.5	50	9/10	9.5
5	25	22	21	65/69	67	29	9/9	12
6	16	14	17	80/78	79	17	10/11	10.5
7	26	24	24	70/76	73	38	9/12	10.5
8	20	22	18	69/74	71.5	15	13/10	11.5
Mean	*24.63*	*20.0*	*23.25*	*68.9/73.1*	*71.0*	*32.3*	*10.4/10.9*	*11.1*
SD	*6.2*	*5.5*	*5.3*	*5.4/5.7*	*5.3*	*12.8*	*1.7/1.6*	*1.1*
Total	197	160	186					

Figure D: *Graphics of Scores from Table 2 and 3*



On the mean level Bridge playing couples scored 25.8 (SD = 3.0), Bridge playing women scored 25.9 (SD = 5.3), and Bridge playing men scored 22.9 (SD = 3.0). Non- Bridge playing couples scored 24.6 (SD = 6.2), non Bridge playing women scored 20.0 (SD = 5.5), and non-Bridge playing men scored 23.3, SD = 5.3.

The unpaired t-test was used to test the two groups of couples. There was no significant difference between Bridge-playing couples (M = 25.8, SD = 3.0) and non-Bridge playing couples (M =24.6, SD = 6.2). The two-tailed P value equals .0652. The confidence interval between the two groups equals 1.120. 95% confidence interval of this difference is between –4.093 and 6.333.

Therefore our hypothesis that Bridge playing couples might achieve better score results than non-Bridge playing couples when tested with this paradigm had to be rejected. However, when looking at the raw numbers on the mean level in Bridge and non-Bridge playing couples, each couple always out scored the weakest individual of the dyad. This supports our findings in chapter 1 where we introduced the used paradigm, and also earlier findings from Baltes & Staudinger (1996), who used wisdom tasks when examining dyadic decision making during dyadic performance.

Further it is to mention that the Bridge playing couples were more decisive than the non-Bridge playing couples. This became obvious when they were asked to participate and also when they were tested with this computerized game. They did not waste time with dyadic discussion when one of the nine games seemed to be difficult but went on to the next game to get the most possible scores there, and in order to stay in the given time limit of ten minutes for all nine games.

3.4 Discussion

The goal of this study was to examine if well-practiced Bridge players had an advantage when working on a complex problem solving task Engle & Bukstel (1978) argued that

memory and problem-solving capabilities come together in the card game Bridge, which would coincide with the skills old couples need to successfully solve their everyday problems independently up to very old age in order to stay independent. Thus, we hypothesized that old couples that play Bridge would perform better in the computerized problem solving paradigm introduced earlier because their Bridge playing expertise and practice might have contributed to improved memory and problem solving skills that would reflect on their complex problem solving skills as a dyad. The hypothesis was that Bridge playing old couples should score higher than old couples of the same or very similar age that do not play Bridge. However, this hypothesis had to be rejected since there was no significant difference when comparing the scores of the Bridge and non-Bridge playing couples tested in a laboratory setting. However, we found that in all sixteen couples (Bridge playing and non-Bridge playing) the score of the couple was always better than the score of the weakest individual. This supports our findings in our first study and earlier findings from Baltes & Staudinger (1996), who used wisdom tasks when examining dyadic decision-making during dyadic performance.

Limitations of exploratory studies with very few participants and the use of convenience samples in studying dyadic problem solving of Bridge playing couples have to be acknowledged. Therefore, we cannot make strong claims about the generlizability of our findings to the general population of old, Bridge playing couples. However, it is to mention that concerning the special skills in Bridge playing, domain knowledge (Hambrick & Oswald, 2005) under which playing Bridge may fall to a certain degree, may not reflect on complex cognitive skills (Frensch & Sternberg, 1991) and, therefore, may explain why there was not a significant difference between Bridge and none-Bridge playing couples when tested with this newly introduced paradigm. In this respect, our results could be seen in favour of the newly introduced paradigm since this paradigm was developed for testing complex cognitive skills of old dyads. If Bridge playing abilities to some extent have to be

classified in the special range of domain knowledge, a different paradigm might be more appropriate for testing.

Returning to our study: The main goal of this study was to explore the possibility that expertise in working on complex and cognitively demanding tasks as a dyad that is practiced when playing Bridge is systematically related to the general dyadic problem solving ability of old dyads. In the exploratory small sample we used, playing Bridge is not a supportive factor when older couples are tested with our paradigm. However, further research in this area with a larger sample of old Bridge playing couples might help to determine if the result is generally valid and also would help to determine the validity of the domain knowledge theory to explain our findings.

4 Dyadic Collaborative Memory: Introducing the Word Combination Test for Couples (WCTC)

4.1 Introduction

Statistics tell us that life expectancy of both genders is constantly on the rise in the Western World (Statistical Abstract of the United States, 2000; Mikrozensus 2006, Deutschland; Bundesamt für Statistik, Schweiz 2005). In Germany, for instance, for the year 2010 the estimated population age 60 and older is 26.6 %, for 2020 it is 31.7 %, and for 2050 it is 44.4 % (DIW Berlin). Therefore, during the next decades the number of couples aged over 65 will rise due to higher life expectancy of both genders. These couples will have to master tasks, responsibilities and problems of their daily lives jointly, up to very old age. To master these problems in their daily lives, a core requirement is the ability to use dyadic collaborative memory. Dyadic collaborative memory focuses on the fact that the individual memories are interdependent and both, individual performances and their complementarity, influence the dyadic memory performance. However, relatively little is known about how old dyads maximize their memory performance, and very few experimental paradigms exist to examine dyadic collaborative memory of old couples.

So far, dyadic memory has mostly been examined through story recall, vacation description, and item recall from a shopping list (Dixon & Gould, 1998; Gould, Lee, & Dixon, 1991; Gould & Dixon 1993; Ross, Spencer, Linardatos, Lam, & Perunovic, 2004). However, most research on old couples in context of dyadic collaborative memory focuses on the sum of the memory of the two individuals and not on the product of interaction of these two memories on which we focus in this study. For this purpose, existing paradigms are not suitable, because they do not examine the products of combined memories in dyads. So far, most paradigms used to examine old dyads' verbal memory, typically use the same word lists for both partners, where then their individual and/or their dyadic memory was tested. However, complementary memory performance of two individuals should be much more efficient and likely when both

partners have to combine their knowledge. Therefore, in this study, each partner of the dyad had a separate word list to memorize. Through memory collaboration the partners had to form a new third word pool, which was the object of scoring. This design was chosen to test to which degree old couples manage to complementarily combine their memory performance to achieve an optimal outcome.

Overall, our study had two main goals: First, to find a paradigm that allows testing dyadic collaborative memory performance in old dyads. We needed to ensure that the product of the collaborative memory of the dyad was measurable. Further, it had to be practicable for old people. For this purpose, we developed the Word Combination Test for Couples (WCTC) that allows for repeated testing, makes high demands on individual and collaborative memory, and gives answer to the question if this collaborative memory is used. It can be used to examine dyadic performance, and is generally applicable with adults of all ages. Our hypothesis was that it could be demonstrated that this paradigm is suitable for old adults since its task was easy to explain and the application is simple. Second, we wanted to explore if old dyads use dyadic collaborative memory strategies, thus suggesting flexibility (Amabile, 1996; Guilford, 1950), and creativity (Gardner, 1993; Cohen, 2000; Cropley, 2002) in the collaboration. Our goal was to determine to which degree old couples' performance depends on the actual collaboration versus the individual abilities of both individuals within the couple such as social and cognitive factors (Wahlberg & Stariha, 1992) or their education and motivation (Ruth & Birren, 1985).

4.2 Method

4.2.1 Participants

Thirty couples were approached through telephone calls and flyers in the suburbs of Zürich. Thirteen couples volunteered to participate in this study. All couples had lived together or had been married and lived together for at least five years or longer. The mother tongue of all participants was German. All participants were healthy, had normal or corrected eyesight,

and normal hearing. The age of the subjects was between 60 and 83 years. The mean age for women was 65.7 (SD = 5.7), and for men 66.6 years (SD = 5.5). The mean of couples' age was 66.2 years (SD = 5.6), and the education level was in the range of 8 to 13 years (M = 10.6 years, SD = 1.8 for couples, M = 10.0 years, SD = 1.7 for women and M = 11.2 years, SD = 1.9 for men).

4.2.2 Materials

Collaborative memory task: Participants were asked to create new valid words by combining two words, one from each partner's word card. We used the simplest version (WCTC-S) of the newly developed Word Combination Test for Couples (WCTC). The test consist of two cards each containing a list of six well-known words (in this case we used only the simple German version since this language was the mother tongue of all participants; see Figure E).

Figure E: *Word Cards Used in Chapter 4 (WCTC-S)*

German Version

Card 1	Card 2	Possibilities
Pulver	**Pelz**	**Pulverfass**
Ofen	**Topf**	**Ofenheizung**
Klavier	**Heizung**	**Klaviertaste**
Mantel	**Taste**	**Pelzmantel**
Schmalz	**Fass**	**Schmalztopf**
Apfel	**Baum**	**Apfelbaum**

4.2.3. Procedure

All participating couples could chose to be tested in their home, the researcher's office, a quiet place in a close library or another quiet place outside. The time scheduled for instructing and testing the couple was 20 minutes. First, each couple was told that each partner would receive one word card, and that each partner had different words written on his/her card. The couple was also told that through combination of the six words each person had on the card, six new known terms could be formed. The task then was that the couple managed to find out each other's words and then had to come up with six new terms of their combined words (see Figure E, Possibilities). After they had received the card, there was one minute of time to learn the words by heart. After one minute, the cards were returned to the researcher. No note taking was allowed. The words from the word cards had to be used in the exact way they were written on the card, e.g., changing words to plural or singular did not count (Hund - Schlitten to Hund**e**schlitten would not have been valid; but Schlittenhund would have been in order). Since the simplest form of WCTC was used here, couples were also told that only six new words were possible. When couples had created a new term, they had to report the word explicitly to the researcher. Each correct term counted as a score of one. In this simple version of the WCTC, a score of six was the maximum. No time limit was set. After finishing the test, each couple was questioned about the liking of the test and if it was perceived as difficult or not.

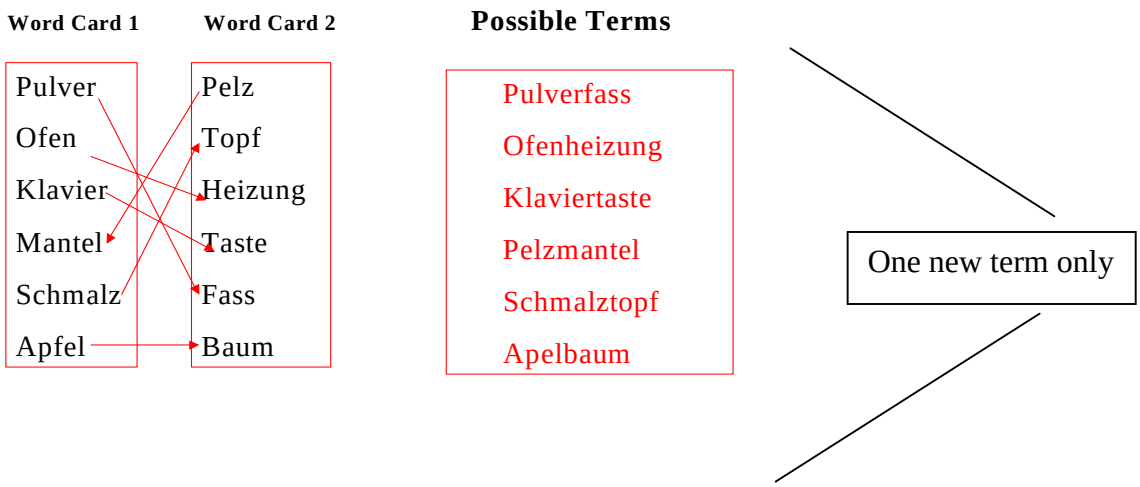
Figure F: Easy and Advanced Version (WCTC-S + A) of Word Combination Test for Couples

Overview of the complete Word Combination Test for Couples (WCTC-S + A)

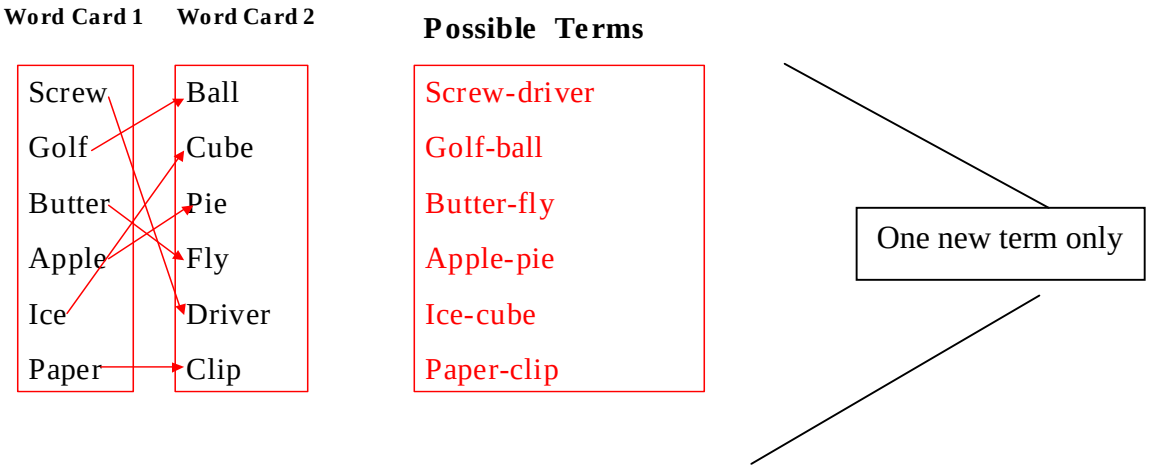
This test was developed to test couples or other dyads on their dyadic collaborative cognitive problem solving skills. It is a verbal test and uses word cards. Every partner of the couple gets a word card with different words, which have to be learned by heart. The test itself directly enforces the collaboration of the tested dyad since partners have verbally to interact to find out what words are available from each partner. After this they try to create new combined terms with their shared words.

The test asks specifically to memorize words and demands the creation of a new term by combining two words through communication with the partner without looking at the word cards or taking notes. The WCTC –S (simple version) can easily be extended in complexity and in degrees of difficulty by choosing more than six words on each word card, and also by choosing words that allow more than one combination. In addition, using words on each separate word card that allow in-between combinations on each single card would increase the complexity of the test (see WCTC-A; advanced version). Although this test was developed to test old dyads, it may also be used to test single persons with a standardized or instructed partner. In addition, the pattern of the test allows testing dyads, couples and single persons in all kind of areas, i.e., only words from a specific content domain could be used. The test, modified for content domain might be helpful to evaluate how well two persons could work together in that particular domain or how well someone might fit in a single position in an area of a specific field in which collaborative memory is required. Below the easy and advanced samples in the English and German language are documented in more detail.

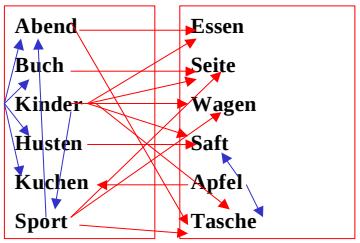
Simple Version, German



Simple Version, English



Advanced Version German



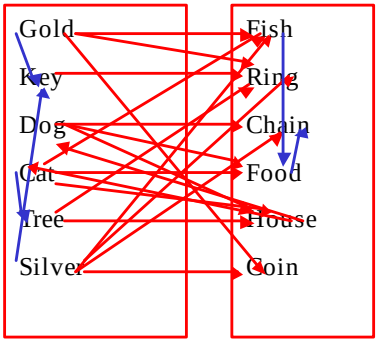
Possible Terms

Abendessen	Sporttasche	Kinderbuch
Buchseite	Sportseite	Kinderabend
Kinderwagen	Sportwagen	Kinderhusten
Hustensaft	Kindertasche	Kinderkuchen
Apfelkuchen	Abendtasche	Apfelsaft
Kinderessen		Apfeltasche
Kinderseite		Sportabend
Kindersaft		Kindersport

Red = terms from orig. 6 words, blue = all in-between terms

In-between and multiple connection

Advanced Version English



Possible Terms

Goldfish	Cat-food	Silver-key
Key-ring	Tree-house	Cat-tree
Dog-food	Silver-Chain	Food-chain
Dog-chain	Silver-ring	Fish-food
Gold-ring	Silverfish	Gold-key
Dog-house	Silver-coin	
Cat-house	House-key	
Catfish	House-cat	
Tree-ring	House-dog	

In-between and multiple connections

Red = terms from orig. 6 words, blue = all in-between terms

4.3 Results

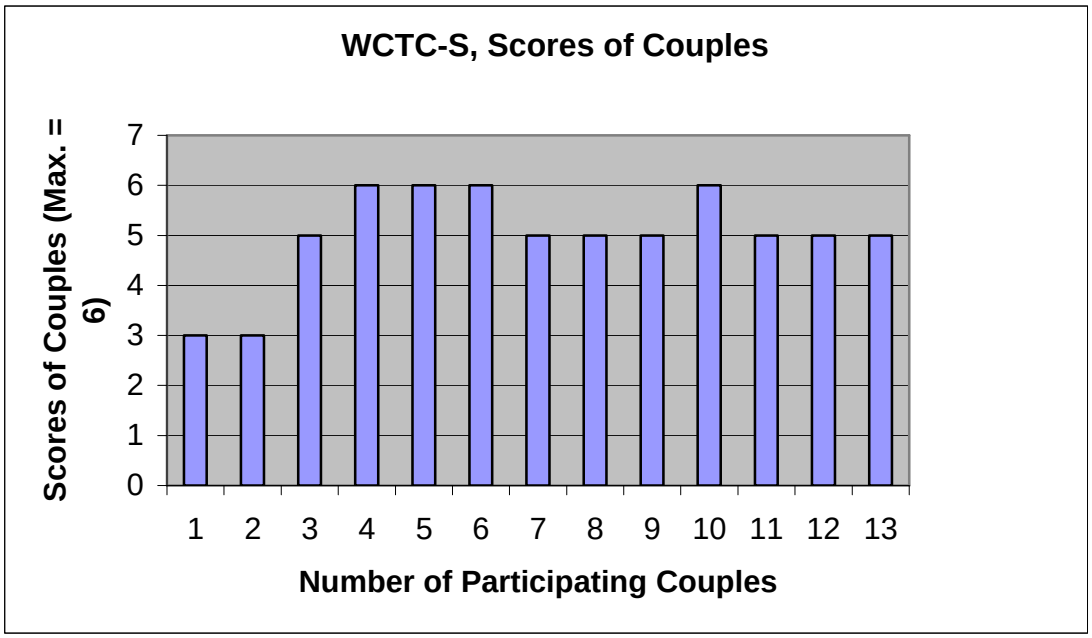
On the mean level, couples scored five out of six possible points or 83.2 percent. Of the 13 couples, four couples scored 100 percent, seven couples scored 83 percent and two couples scored 50 percent.

Version of WCTC-S
(**Six words on each card, no in-between or multiple connections possible, one new term only)**

Table 4: *Scores and Data of 13 Participating Couples – Simple Version WCTC-S*

Couple	Age Female/Male	Together	Years of Edu Female/Male	Nr. of Terms possible	Nr. Of used words	Number of Terms created	Score in %
1	62/66	43	10/13	6	6	3	50 %
2	64/65	40	10/10	6	6	3	50 %
3	70/66	31	9/13	6	10	5	83 %
4	60/66	11	12/13	6	12	6	100 %
5	65/68	38	13/13	6	12	6	100 %
6	60/64	28	13/10	6	12	6	100 %
7	66/65	39	10/10	6	10	5	83 %
8	70/73	47	8/10	6	10	5	83 %
9	78/82	53	8/8	6	10	5	83 %
10	73/65	31	9/13	6	12	6	100 %
11	66/64	10	9/10	6	10	5	83 %
12	60/60	36	11/9	6	10	5	83 %
13	60/62	20	9/13	6	10	5	83 %
Mean	*65.7/66.6*	*32.8*	*10.0/11.2*	*6*	*10*	*5*	*83.2 %*
SD	5.7/5.5	*13.0*	*1.7/1.9*	*0*	*2*	*1*	*0.16%*

Figure G: *Graphic of Scores from Table 4 – Scores of Couples*



Looking at the raw numbers, the result was that all but two of these couples became quite efficient through collaboration (Dixon, Fox, Threvithick, & Brundin, 1997) and scored the maximum or very close to it. All couples had used collaborative memory during the test since even the lowest score was three out of six. That indicated that all individuals within the couples used interactive memory in collaboration with the partner, which then resulted in a positive outcome for the dyadic collaborative memory capacity of the couple.

4.3.1 Paradigm practicability

The simple version of the verbal dyadic memory paradigm WCTC was designed to measure collaborative dyadic memory within a dyadic testing situation. Individual memory was needed to acquire the rules in form of learning words from a card. Combined memory through dyadic collaboration was required to present one new verbal term out of two combined words, one from each individual of the dyad. The number of new terms was the dependent variable. The task itself was easy, however, the approach to solve the task correctly could differ. Therefore, we observed throughout the experimental study if this collaborative memory task could be further optimized or if it was already sufficient in context of our focus.

4.3.2 Observed behavioral results

All individuals had found a technique how to introduce each other to the words of the partner. One technique was to go word-by-word, meaning one partner named a word, then the other partner tried to match one of his/her words to create a new term. Another technique was that one partner first named all of the words he/she remembered, and then the other partner did the same. Eventually, both tried to create the terms out of the words they remembered. To remember their own six words some individuals used an alphabetical approach, others tried to form groups (e.g., food or plants) and two people tried to connect the words to former episodes of their lives. Some individuals were successful with remembering all six words; others could come up with only five or fewer words. The same is true for constructing the six new terms conjointly out of the dyad's words. It should be noted that the combined memory task in this study might seem extremely simple, especially since no time limit was set for the collaborating part of the test. The reason that time was not limited is based on the fact that normal adults will typically be able to store five to nine words, chunks or items in their working- or short-term memory (Klatzky, 1980). Without constant rehearsal, these words will not be remembered very long. But here, time for rehearsal was not provided since the couples had to start immediately with the collaborating task after they had learned their words which took all less than the given one-minute. All couples performed their dyadic collaborative task in a time frame of three to seven minutes. After that, couples either had found their six new terms, or they gave up since the memory for their words faded and they had the feeling there was no way to create another term. This reflects that the paradigm in the way it was applied already contained a time limiting factor, which was given through the human short-term memory construction.

When the couples were asked about their liking of the test, all stated that they appreciated the easy application and the fact that no complicated rules had to be learned. Some individuals were wondering why they could not remember all of their six or at least five

words, even when they were very sure they knew all of them by heart when starting the collaborating task. These persons thought they must simply have had a mental blackout, which resulted in a low score for the couple since only a few new terms could be found through collaborative memory. In the beginning actually all couples were convinced that it would be very easy to remember their six words and work together with the partner and his/her six words. After the test all couples stated that the task was more challenging than they had thought.

Returning to the initial question ”Do older couples use collaborative memory and if so how well do they perform?” the answer according to this study is: Yes, they do use collaborative memory, at least when they have to, like it was the case when tested with this paradigm, and they even perform well on average.

4.4 Discussion

Dyadic collaborative memory is closely connected to dyadic cognitive problem solving that is necessary for couples to manage their combined lives. Like dyadic cognitive problem solving, dyadic collaborative memory will become increasingly more important as life expectancy is on the rise and consequently will produce a higher number of old couples. The two individuals of an old couple may have very different backgrounds concerning education, social and emotional standards and worldviews. In any case, different levels of individual cognitive problem solving abilities have to be expected. The question here was: Do old couples use dyadic collaborative memory during dyadic problem solving at all and if so, how well do they perform? So far, most studies on collaborative memory in old dyads have focused on verbal memory paradigms in which both individuals receive an identical word list. In this study each partner of the couple had a complementary word list. Through collaboration and exchange of memory the dyad had to form a new pool of words. This way of studying complementary dyadic collaborative memory is a new approach that is similar to everyday

situations in which it is most effective if dyadic partner distribute the memorizing responsibilities between themselves instead of trying to memorize the same items. Therefore, our goal was to introduce a paradigm that calls for equal cooperation of the two individuals of a couple, and determines how well old couples perform on a dyadic collaborative memory task. Based on our findings, we believe we found such a paradigm since it forced the individuals of the couple to close cooperation on their memory level and it gave way to interpretation how well the couple mastered the dyadic collaborative memory task.

Limitations of exploratory studies with very few participants and the use of convenience samples in studying dyadic collaborative memory have to be acknowledged. However, the main focus of this study was to present an experimental paradigm that could be used to examine and compare dyadic collaborative memory in a repeated measure design, and to collect data on the possibilities to optimize the paradigm for future more widespread use in cognitive aging research. Although we cannot make strong claims about the generalizability of our findings to the general population of old couples, the finding that all couples used dyadic collaborative memory and performed well suggests that the basis for examining the complementary ways how old individuals within couples perform in dyadic collaborative memorizing has been laid. In fact, the results in our sample showed, four out of 13 couples could remember all their words and came up with the maximum six new terms. Seven couples were successful with five new terms and only two couples came up with half of the maximum terms, which meant they found three new terms. This tells that all couples had used the collaborative memory when forming the new terms. The couples seemed to like to make use of some collaborative memory even if their result was not always 100%. This suggests that old couples co-jointly do use dyadic collaborative memory when necessary. One reason for this positive result may lay in the choice of a verbal paradigm. As research suggests, old people tend to have a large vocabulary, which normally remains stable until old age (Sattler, 1982; Schaie, 2005) so collaborative memory on a verbal level might be an easy task for

them. Nevertheless, the grade of education (Bowles, Gimm, & McArdles, 2005) of the couples' individuals may have had an influence on the outcome of this study. Since the 13 couples scored 83% on the mean level on the simple version of the WCTC, which suggests a ceiling effect of the simple version of the paradigm might be eventually suspected. Therefore, the results of this study lead us to the next study where the same participants will be tested on a more difficult version of this paradigm.

So far the results mean that old couples are very well able to deal with dyadic collaborative memory when dyadic performance depends on complementary efforts to memorize items. To verify this positive result concerning old couples, further research with a larger sample and more specified age groups (young-old, old, very old) is still needed. If the results can be replicated across larger samples and age ranges, important implications can be drawn from this study. For one, old couples, due to maximizing their memory performance through dyadic collaboration, may be better able to solve everyday problems when strong collaborative memory is required by the task. Couples that are better able to work together when strong collaborative memory is necessary might enhance their dyadic well being through this more efficient and eventually less effortful dyadic memory. Since in the future other models of aging than we know today may become relevant, it is possible that collaborative memory may become extremely important in dyadic problem solving.

5 Dyadic Collaborative Memory: Performance when tested with the complex paradigm WCTC-A

5.1 Introduction

Life expectancy of both genders is constantly on the rise in the Western World (Statistical Abstract of the United States, 2000; Mikrozensus 2006, Deutschland; Bundesamt für Statistik, Schweiz 2005). Consequently the number of old couples will increase and these couples will have to master tasks, responsibilities and problems of their daily lives jointly, up to very old age. To master these problems in their daily lives, a core requirement is the ability to use dyadic collaborative memory. However, relatively little is known about how old dyads maximize their memory performance, and very few experimental paradigms exist to examine dyadic collaborative memory of old couples. Even less is known how old couples perform when they have to use dyadic collaborative memory under difficult and/or stressful circumstances.

So far, dyadic memory has mostly been examined through story recall, vacation description, and item recall from a shopping list (Dixon & Gould, 1998; Gould, Lee, & Dixon, 1991; Gould & Dixon 1993; Ross, Spencer, Linardatos, Lam, & Perunovic, 2004). Also, most research on old couples in context of dyadic collaborative memory focuses on the sum of the memory of the two individuals and not as the product of interaction of these two memories on which we focus when using the WCTC. So far, most paradigms examining old dyads' verbal memory typically use the same word lists for both partners, where then their individual and/or their dyadic memory is tested. However, complementary memory performance of two individuals should be much more efficient and likely when both partners have to combine their knowledge, especially when the task becomes more difficult (Berg & Upchurch, 2007). Therefore, in this study, each partner of the dyad had a separate word list with six words in each case to memorize. Through memory collaboration the partners had to form a new third word pool, which was the object of scoring. In this advanced version of the WCTC that we used, 21

new terms were possible compared to the six new terms that were possible in the simple version. This design was used to test to which degree old couples manage to complementarily combine their memory performance to achieve an optimal outcome under a more complex situation than in our prior study. Chances are that there might be seen a decrease of individual and dyadic memory which will lead to lower dyadic cooperation and result in lower scoring due to the more complex testing situation. Normally, under great stress the process of thinking is characterized by loss of concentration, inability to perceive new information, hampered short-term memory, rumination, lack of initial planning of actions, and hasty decision making (Massa Watkins, & Partridge, 2002). In consequence of that, collaborative memory might equally suffer or not be used at all. Also the personal adaptation of each individual in the dyad (Gohm, Baumann, & Sniezek, 2001) to the more complex situation may play an important role in the achievement of the overall dyadic performance when dyadic collaborative memory is tested in this context. Also the behavior of and between the individuals may change due to time pressure (Stokes, Kemper, & Marsh, 1992) and work overload concerning memory, produced through the complexity of the paradigm (Andre, 2001).

Overall our study had two main goals: First, we developed the advanced Word Combination Test for Couples (WCTC-A) that allows for repeated testing, makes high demands on individual and collaborative memory, and gives answer to the question if collaborative memory is used by old couples in a complex testing situation. This complex paradigm is generally applicable with adults of all ages. Our hypothesis was that it could be demonstrated that this paradigm is suitable for old adults since its task was easy to explain and the application was as simple as in our prior study, where the simple version of this paradigm was used. Second, we wanted to explore if old dyads use dyadic collaborative memory strategies, thus suggesting flexibility (Amabile, 1996; Guilford, 1950), and creativity (Cohen, 2000; Cropley, 2002; Gardner, 1993;) in the collaboration when the task became more complex. Further, we wanted to evaluate if the behavior of the dyad as such and

between the individuals changed with regard to the more complex task of the here used paradigm WCTC-A. A change of behavior in comparison when using the simple version of WCTC-S was expected since the complexity of the WCTC-A included an increase of time pressure and memory load that possibly may have an impact on behavior.

5.2 Method

5.2.1 Participants

Thirty couples were approached through telephone calls and flyers in the suburbs of Zürich. Thirteen couples volunteered to participate in this study. All couples had lived together or had been married and lived together for at least five years or longer. The mother tongue of all participants was German. All participant were healthy, had normal or corrected eyesight, and normal hearing. The age of the subjects was between 60 and 83 years. The mean age for women was 65.7 (SD = 5.7), and for men 66.6 years (SD = 5.5). The mean of couples' age was 66.2 years (SD = 5.6), and the education level was in the range of 8 to 13 years (M =10.6 years, SD = 1.8 for couples, M = 10.0 years, SD = 1.7 for women and M = 11.2 years, SD = 1.9 for men).

5.2.2 Materials

Collaborative memory task: Participants were asked to create new valid words by combining two words; they could be from their own card and also from each partner's word card. The test consist of two cards each containing a list of six well-known words (in this case we used only the advanced German version since this language was the mother tongue of all participants; (see Fig. H).

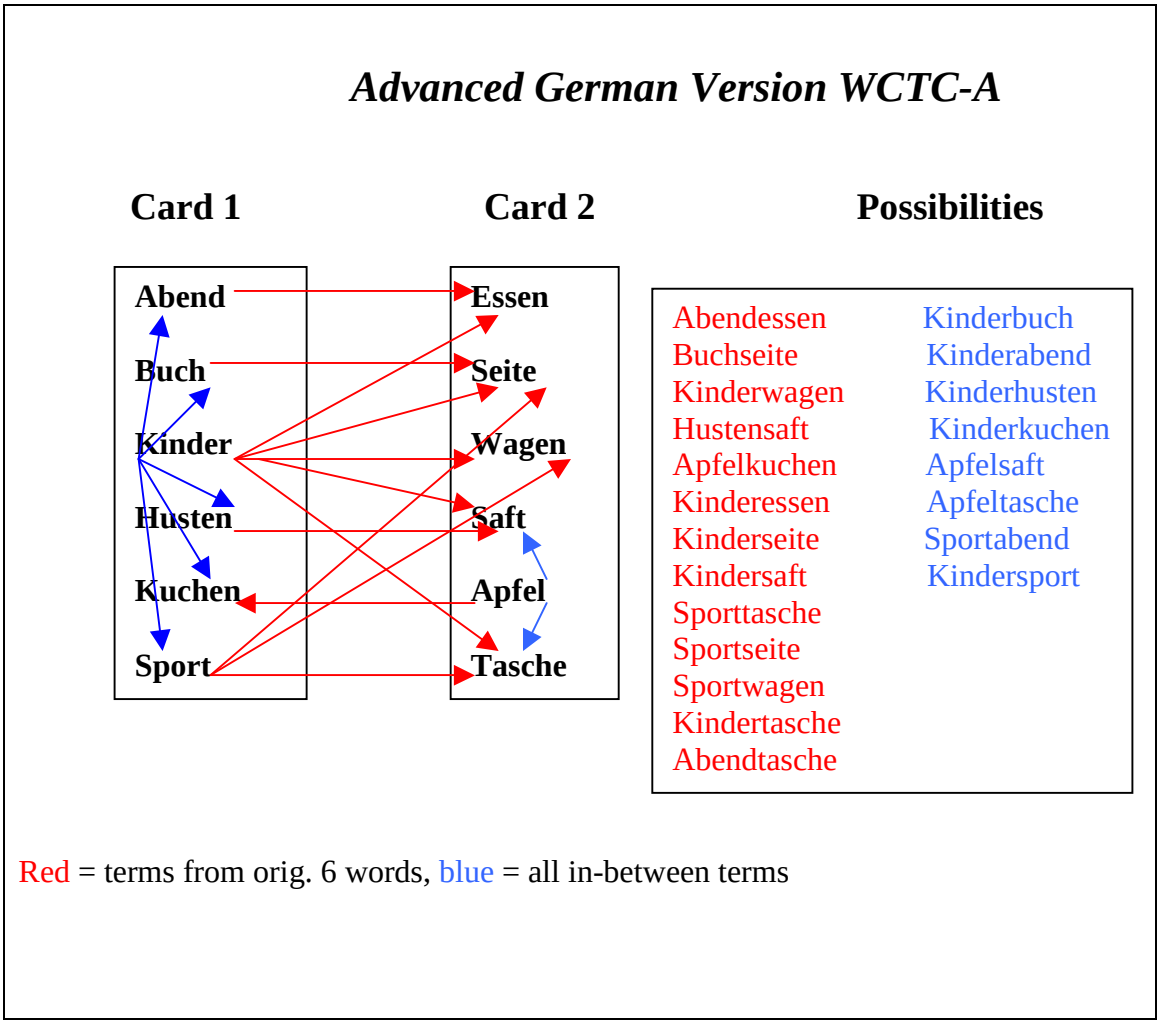
5.2.3 Procedure

All participating couples could chose to be tested in their home, the researcher's office, a quiet place in a close library or another quiet place outside. The time scheduled for instructing and testing the couple was 25 minutes. First, each couple was told that each partner would

receive one word card, and that each partner had six different words written on his/her card. The couple was told that through combination of the six words each person had on the card, multiple new known terms could be formed. The couple was informed that there possibly could be word combinations between the six words each individual had on his/her card. The assigned task now was that the couple managed to find out each other's words and then had to come up with all the new created terms of their own and combined words (see Figure H; Possibilities). After both partners of the couple had received their word card, the participants had one minute to learn the words by heart. After one minute, the cards were returned to the researcher. No note taking was allowed. The words from the word cards had to be used in the exact way they were written on the card, i.e. changing words to plural or singular did not count (Hund - Schlitten to Hund**e**schlitten would not have been valid; but Schlittenhund would have been in order). Since the advanced form of WCTC was used here, couples were not told the exact number of new words possible, they were only told that a lot more than six new terms could be created. When couples had created a new term, they had to report the word explicitly and immediately to the researcher. Each correct term counted as one score. In this advanced version WCTC-A, 21 scores were the maximum. No time limit was set. After finishing the test, each couple was questioned about the liking of the test and if they perceived it as difficult or not.

Note: *For the complete Word Combination Test for Couples, WCTC-S and WCTC–A see Chapter 4, Figure F.*

Figure H: *Word Cards Used in Chapter 5 (WCTC-A)*



5.3 Results

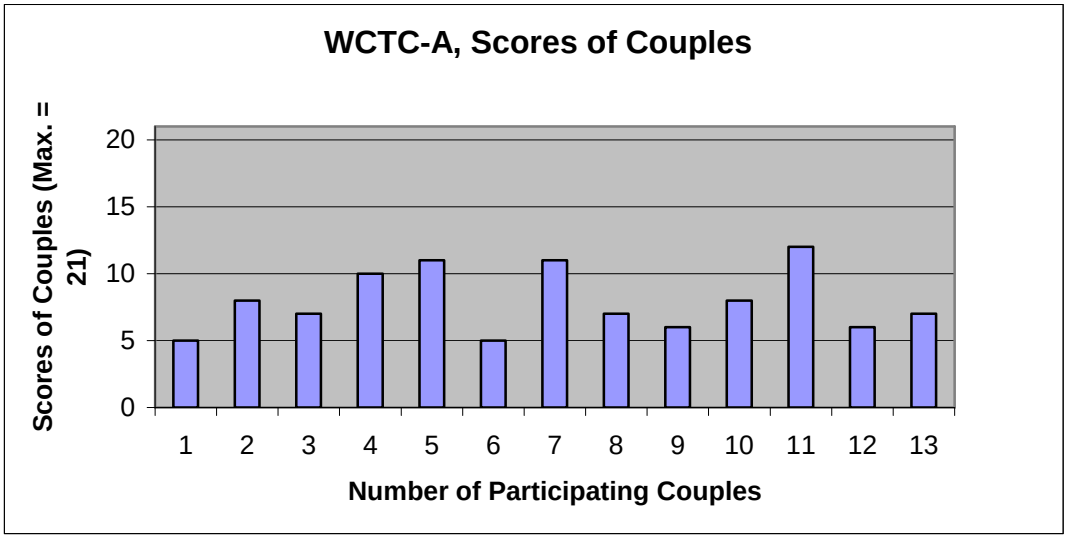
On the mean level, couples scored eight out of 21 possible points, or 38.1 percent. Of the 13 couples, one couple scored 57.1 percent, two couples scored 52.4 percent, one couple scored 47.6 percent, two couples scored 38.1 percent, three couples scored 35 percent, two couples scored 28.6 percent, and two couples scored 23.8 percent.

WCTC-A
(Six words on each card, within and across lists and multiple combinations possible)

Table 5: *Scores and Data of 13 Participating Couples WCTC-A*

Couple	Age Female/Male	Years together	Years of Edu. Female/Male	Nr. of Terms possible	**Nr.** of used Words	Nr. of Terms created	Score in %
1	62/66	43	10/13	21	5	5	23.8 %
2	64/65	40	10/10	21	9	8	38.1 %
3	70/66	31	9/13	21	8	7	35.0 %
4	60/66	11	12/13	21	11	10	47.6 %
5	65/68	38	13/13	21	11	11	52.4 %
6	60/64	28	13/10	21	5	5	23.8 %
7	66/65	39	10/10	21	10	11	52.4 %
8	70/73	47	8/10	21	6	7	35.0 %
9	78/82	53	8/8	21	6	6	28.6 %
10	73/65	31	9/13	21	6	8	38.1 %
11	66/64	10	9/10	21	10	12	57.1 %
12	60/60	36	11/9	21	6	6	28.6 %
13	60/62	20	9/13	21	7	7	35.0 %
Mean	*65.7/66.6*	*32.8*	*10.0/11.2*	*21*	*7.7*	*8*	*38.1 %*
SD	*5.7/5.5*	*13.0*	*1.7/1.9*	*0*	*2.3*	*2.4*	*11.1%*

Figure I: *Graphic of Scores from Table 5 – Scores of Couples*



Looking at these numbers and the conception of the paradigm used in this study, the result showed that the couples were efficient through collaboration (Dixon, Fox, Threvithick, & Brundin, 1997) and they scored 38.1% on the mean level. Participants did not particularly concentrate on finding combinations on their own card. Even when six combinations from one word card were possible, in maximum only one or two of these combinations were found by a couple. That indicated that all individuals concentrated mainly on the interactive memory in collaboration with the partner, which then resulted in a positive outcome for the dyadic collaborative memory capacity of the couple. The mean level score of 38.1 %, which is orientated on the 21 possible combinations, indicated that the testing situation when using the WCTC-A was a more complex situation for the participants than when tested with the WCTC-S. The results also showed that the old couples in average found eight new combinations but were not able to exhaust all possibilities of the paradigm since finding twelve new combinations (57.1%) out of 21 possible ones, was the maximum in our sample. Still, when looking at the number of words the couples used in connection with their new created combinations, the results are better than when tested with the simple version WCTC-S. When using totally six words in this study, couples created at least six to eight new terms. When totally using 10 or 11 words they were able to create 10 to twelve new terms. This was different when using the WCTC-S because here only one combination was possible between each word of the partners; consequently six new terms were the maximum. As we already suspected, this may have caused a ceiling effect during testing when using the WCTC-S, whereas the results when old couples were tested with the WCTC-A did not allow an educated guess of a ceiling effect.

5.3.1 Paradigm practicability

The advanced version of the verbal dyadic memory paradigm WCTC was designed to measure collaborative dyadic memory within a more complex dyadic testing situation compared to the testing with the simple version of the WCTC. Combined memory through

dyadic collaboration was required to present up to 21 new verbal terms, created through combination of the words of both individuals, and including possible combinations from the six words of the word card of each individual. The final number of new terms was subject to scoring. The task itself was demanding since individual and combined dyadic memory had to be used in interaction, and the approach to solve the task correctly could differ. Therefore, we observed throughout the experimental study if this collaborative memory task could be further optimized or if it was already sufficient in context of the focus of more complexity of this paradigm.

5.3.2 Observed behavioral results

All individuals had found a technique how to introduce each other to the words of the partner. One technique was to go word-by-word, meaning one partner named a word, then the other partner tried to match one of his/her words to create new terms. The most successful technique to use in this study was that one partner first named all of his/her words and than the other partner did the same. Eventually both tried to create terms out of the words they remembered. This could include terms out of their own six words when possible. It should be noted that the combined memory task in this study might have felt quite challenging, even when no time limit was set for the collaborating part of the test. High time pressure (Stokes, Kemper, & Marsh, 1992) still existed even when no time limit was set. The reason that time was not limited is based on the fact that normal adults will typically be able to store five to nine words, chunks or items in their working- or short-term memory (Klatzky, 1980). Without constant rehearsal, these words will not be remembered very long. But here, time for rehearsal was not given since the couples had to start immediately with the collaborating task after they had learned their words which took all less than the given one-minute. Thus fading of the memory presented the time pressure. All couples performed their dyadic collaborative task in a time frame of three to twelve minutes. After that the couples had the feeling there were no more terms possible to create. Some of the couples came up repeatedly with the same new

term, a tunneling effect (Wickens & Hollands, 2000), and then they gave up. Another observed effect was, when dyads were unsuccessful to create further new terms, often they produced combinations from words that were not given at all (Gallo, Roberts, & Seamon, 1997; Goff & Roediger, 1998). Nevertheless, the couples were convinced they have had these words on their word cards. Here, the imagination of false memory, which can develop under enormous cognitive stress, may have occurred (Payne, Nadel, Allen, Thomas, & Jacobs, 2002; Roediger & McDermott, 1995). Also the behavior of some individuals in the dyads reflected that the testing situation might have been more tense than when the simple version of the WCTC was used. The conversation between some partners was hectic and often included critics on the partner's decision and/or behavior (Easterbrook, 1959; Kensinger & Corkin, 2003; Richards & Gross, 2000;). This in turn may have interrupted the concentration of the couple on their given task and the result then was a decrease of collaboration followed by lower scores. Questioning the participating couples after taking the test with the WCTC-A resulted in the following: It was appreciated that the paradigm was well manageable; no time consuming preparation was necessary, and no specific tools had to be used. The advanced WCTC was felt as demanding on the memory and the collaborative part. Since all couples were convinced that the possibility of creating multiple new terms would enhance their dyadic collaborative memory and would result in high scores, the outcome, that the number of new created terms lay between five and twelve, was disappointing to them.

Returning to the question: How do old couples perform in a dyadic collaborative memory test with high complexity (given by huge memory work load and time pressure)? The answer is: They did well in adjusting their collaborative memory task to the more complex situation, when creating eight terms in average.

5.4 Discussion

Dyadic collaborative memory is closely connected to dyadic cognitive problem solving that is necessary for couples to manage their combined lives. Like dyadic cognitive problem solving, dyadic collaborative memory will become increasingly more important as life expectancy is on the rise and consequently will produce a higher number of old couples. The two individuals of an old couple may have different backgrounds concerning education, social and emotional standards and worldviews. In any case, different levels of individual collaborate memory abilities have to be expected. When the simple version of the Word Combination Test for Couples (WCTC-S) was used for testing, the same participants which are tested in this study performed well (83%). The question now was: How do the same participants perform when the advanced, more difficult version of the WCTC is used to test their dyadic collaborative memory? So far, most studies on collaborative memory in old dyads have focused on verbal memory paradigms in which both individuals receive an identical word list. In this study each partner of the couple had a word list that complemented the partner's in the sense that through collaboration and exchange of memory the dyad could form a new pool of words. This way of studying complementary dyadic collaborative memory is a new approach that is similar to everyday situations in which it is most effective when dyadic partners distribute the memorizing responsibilities between themselves instead of trying to memorize the same items. Further, in the advanced form of the WCTC multiple combinations of the words were possible, which made the task for the participants more complex. Here our goal was not only to introduce a paradigm that claims dyadic cooperation of the two individuals of a couple, but also determines how well old couples perform in a dyadic collaborative memory task when the task became more complex through the used paradigm.

Limitations of exploratory studies with very few participants and the use of convenience samples in studying dyadic collaborative memory under demanding circumstances have to be

acknowledged. However, the main focus of this study was to present an experimental paradigm that could be used to examine and compare dyadic collaborative memory in a complex and highly demanding task in a repeated measure design, and to collect data on the possibilities to optimize the paradigm for future more widespread use in cognitive aging research. Although we cannot make strong claims about the generalizability of our findings to the general population of old couples, the finding that in the WCTC-A all couples used dyadic collaborative memory and remembered an average of eight new word combinations suggests that the basis for examining the complementary ways how old individuals within couples perform under difficult circumstances of dyadic collaborative memorizing has been laid. In fact, the results in our sample showed the participants scored between 23 and 57 percent, and the mean level was 38 percent, which means they created in average eight new terms. This tells that all couples had used the collaborative memory when forming the new terms in the more complex WCTC-A test. The couples seemed to like to make use of some collaborative memory even when they could not exploit the whole spectrum of the test, namely 21 new terms. This suggests that older couples co-jointly do use dyadic collaborative memory in complex situations, when necessary. However, literature tells (Massa, Watkins, & Partridge 2002; Flin, 2004) that cognitive capacity may suffer under stressful conditions and so may collaborative memory. Typical reported problems are narrowing of attention (tunnel vision) which our participants showed when they repeatedly came up with the same new term. Lack of concentration was seen when the words were not remembered or no combination was found, and imagination of false memory happened when participants used words that were not at all included in the test but they were convinced they had read them on their cards. Of course each individual has his/her own limits in a complex test but in a dyadic venture the dyadic effort probably is not only influenced by the pressure that the individuals feel but how the two individuals of the dyad manage their combined memory in a complex situation. Additionally the grade of education (Bowles, Gimm, & McArdles, 2005) of the couples'

individuals and the fact that old people tend to have a large vocabulary that normally stays stable (Sattler, 1982) may have influenced the outcome of this study.

So far, the results mean that old couples are able to deal with dyadic collaborative memory when a complex situation predominates and they successfully try to adjust their dyadic task to the level of difficulty. To verify this result concerning old couples, further research with a larger sample and more specified age groups (young-old, old, very old) is still needed. If these results can be replicated across larger samples and age ranges, important implications can be drawn from this study. For one, old couples, due to maximizing their memory through dyadic collaboration are able to solve every day problems when strong collaborative memory is required by a complex task. Couples that are able to work together in situations when strong collaborative memory is necessary may enhance their dyadic well-being since they can rely on their combined memory strength to solve even difficult problems. Being able to master problems still independently when using collaborative memory, will give security and peace of mind to an old couple for its joint life into the future.

6 General discussion

Dyadic cognitive problem solving is a complex task, which is necessary for couples to manage their combined lives. It will become increasingly more important as life expectancy is on the rise and this consequently will produce a higher number of old couples. In addition, as Berg and Upchurch (2007) have pointed out, lifespan developmental differences have been found in the nature of the marital relationship across adulthood (Carstensen, Graff, Levenson, & Gottman, 1996), such that older adults experience increased marital satisfaction as opposed to couples at other points in the lifespan. Long-term marriages are often characterized by shared aims, goals, decision making (Lauer, Lauer, & Kerr, 1990) and intimacy (Goodman, 1999), features that may reflect shared appraisal of stressors and greater use of collaborative forms of involvement. Older marriages involve less potential for conflict and greater potential

for pleasure (Levenson, Carstensen, & Gottman, 1993), less negative and more affectionate behavior during conflict discussions (Carstensen, Gottman, & Levenson, 1995) and smaller physiological responses to conflict than is evident in the relatively shorter marriages of middle-aged adults.

These differences in relationship quality may relate to more effective use of collaboration in older couples. From the collaborative problem-solving literature, long-term married couples demonstrate “collaborative” expertise (shared experiences, knowledge of each other’s strengths and weaknesses), which facilitates the more active and engaged form of collaborative problem solving (Dixon & Gould, 1996). For instance, older spouses may know when to increase (or decrease) their level of involvement with greater knowledge of the preferences, efficacy, and distress of their partner. Older adults are better able to benefit from collaborative processes than young adults (Gould, Trevithick, & Dixon, 1991), as they have greater skill at reminding and joint remembering (Wegner, Erber, & Raymond, 1991) and generating strategy discussion that facilitates problem solving. This greater collaborative skill of older couples could be used in the course of dealing with chronic illness as problems arise surrounding seeking information, making treatment decisions, and planning for long-term management of the illness. Collaborative coping provides older adults with an additional resource in this decision process. In any case, the two individuals of an older couple may have very different backgrounds concerning education, social and emotional standards and worldviews. In any case, different levels of individual cognitive problem solving abilities have to be expected. Still, couples walk through life together and have to solve problems jointly. To examine such a joint venture like cognitive problem solving of old couples, paradigms are needed that can come to terms with the complexity of the task, which means they have to be complex in themselves but still are simple enough to be handled by old people. They should include as many as possible of the fundamental skills of problem solving tasks such as planning, learning, memory, retrieval and decision-making for testing.

As Martin & Wight (2008) have pointed out, a number of paradigms have been or may be used to examine dyadic cognition in old age. Most paradigms may potentially be used to establish age and dyadic collaboration effects in dyadic cognition and to examine the role of particular explanatory mechanisms, but have not been used for this purpose. Therefore, more empirical research is needed to establish and understand the phenomena of dyadic cognition in old age, the potentials and adaptive capacities old dyads may possess and to improve our understanding in which types of tasks and in which dyadic constellations it is preferable to collaborate and which individual efforts are leading to better task performance. With respect to paradigm development, they suggest a need for standard paradigms to be used to for individual, dyadic and repeated individual and dyadic testing for problem solving performance. In addition, paradigms that clearly dissociate the required abilities would allow to better understand how dyads manage the abilities and responsibilities to optimize dyadic task performance. Thus, the computerized paradigm introduced in Chapter 2 fulfilled this requirement rather well. It contained most of the mentioned tasks, and concerning memory it even included spatial memory. It was manageable by old couples and individuals as the test results showed and it was reflective of everyday problem solving. Looking at the overall results of old couples when using the computerized game and taking into account that we cannot make strong claims about the generalizability of our findings to the general population of older couples due to the small sample size, the finding that in all couples performance was best in the dyadic condition and that couples performed all better than nominal pairs suggests that the basis for examining the complementary ways in which old individuals within couples perform problem solving, has been laid. In the future when old people will all be very familiar with computer tasks this might become a very popular paradigm for testing old couples and old individuals on problem solving.

The WCTC paradigm that was introduced in Chapter 4 and 5 is a verbal test that was developed to test dyadic collaborative complementary memory of old couples. This paradigm

was constructed in a way to automatically induce the collaboration of the two partners and testing then the results of the combined memory of the old couple. So far mostly paradigms were used only in the way that the combined memory of an old couple consisted of the memory of each individual added from the same task. Combined constructive collaboration was actually not measured. The WCTC paradigm accommodates old people since it is easy in application and it comes into operation in the verbal realm were they often have a wide range of knowledge (Sattler, 1982). In addition this paradigm can be extended so that it is usable for other tests than on collaborative memory of old couples.

When testing complementary collaborative memory of old couples and using the verbal paradigm WCTC old couples did very well, that means through collaboration of their individual memories they achieved extremely good results when the simple form of the paradigm was used for testing their combined memory task. When using the advanced version of the WCTC paradigm it became clear that old couples could successfully adjust their dyadic task performance to a more difficult level concerning collaborative memory. However, here also no strong claims about the generalization of the findings to the general population can be made due to the small sample size. It is to hope that further research on larger samples can lead to important implications drawn from this study.

Generally, limitations of exploratory studies with very few participants and the use of convenience samples in studying dyadic problem solving have to be acknowledged. However, the main focus of this thesis was to present experimental paradigms that could be used to examine and compare individual and dyadic problem solving performance in a repeated measure design, and collect data on the possibilities to optimize the paradigm for future more widespread use in cognitive aging research. Although we cannot make strong claims about the generalizability of our findings to the general population of old couples, the finding that in all couples performance was best in the dyadic condition, and that couples performed all better than nominal pairs suggests that the basis for examining the complementary ways in which

old individuals within couples perform problem solving, has been laid. In fact, providing practicable paradigms to be able to examine dyadic – and complementary – problem solving and memory performance is an essential step into the direction of gaining insight into the "true" ability level of old individuals. To verify our positive results from the preliminary studies concerning old couples, further research with larger samples are, of course, still needed. This will suggest important implications: For one, old couples, due to their stable dyadic skills in cognitive problem solving are able to solve everyday problems independently, i.e., without the help of individuals from outside the dyad. This is an important distinction from a view on cognitive aging that focuses on the individual where the complementary support from a spouse would already be seen as outside interference and, thus, sign of dependency. Even more generally speaking, research on the issue of dyadic problem solving may lead to old people being seen less as a burden to society (based on individual deficits in functioning) and more as a well functioning, big part of the society, that is able to solve its every day problems independently. Since in the future other models of aging than we know today may become relevant, it is possible that old couples, due to their good dyadic complex cognitive problem solving tasks, could become role models when it comes to dyadic cognitive problem solving skills, or at least, they can function as an excellent resource in many realms of future societies when dyadic cognitive problem solving is required.

Overall it is to say that every day's cognitive problem solving of old couples needs further research since in the future even more old couples than today will be part of society. How this part of society manages their joint lives in old age has to be of interest of the whole society since it will influence many scopes and might change the view of old age as such. To be able to execute this necessary research more specific new paradigms may be needed. So, research has to focus on that as well. For sure there are quite some possibilities to develop more paradigms that may be used to examine old couples' cognitive problem solving

performance. They just have to be discovered or eventually to be invented, which might not be too hard when researchers try to put themselves in old people's place.

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